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Final Technical Report
August 1980

16 KB/S MODEM (AN/GSC-38) CONUS TEST

Harris Corporation

Daniel D. McRae

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

RADC-TR-80-89 has been reviewed and is approved for publication.

APPROVED: Salvatore J. Nasci

SALVATORE J. NASCI
Project Engineer

APPROVED: Fred I Diamond

FRED I. DIAMOND, Technical Director
Communications and Control Division

FOR THE COMMANDER: John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office

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A test program was conducted for the purpose of evaluating performance of the Harris 16 kb/s Modem operating over the CONUS Autovon network. ~~Measurements were made with~~ the modems operating in a full-duplex configuration over four-wire Autovon connections and in a simplex configuration over two-wire Autovon connections. In addition to the 16 kb/s measurements, tests were conducted at 8 kb/s using the 8 kb/s mode of the 16 kb/s modem and at 9.6 kb/s using a commercial modem. (over)

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In all, 1425 calls were placed in which bit-error-rate (BER) performance was measured. Nine different CONUS subscriber locations were involved. In addition to normal calls between modems located at different subscriber locations, loop-around calls were placed to most of the network switches.

The general results indicate that if the access line from the subscriber location is a "good" one, the 16 kb/s modem is capable of providing BER values less than 1 ~~percent~~ % on over 90 ~~percent~~ % of the randomly dialed lines even when an emergency network condition is simulated. The "good" access lines appear to be those which do not involve N carrier or the early version of T carrier systems (those involving DIA or D1B channel banks). Sixteen kilobit performance over N1 carrier system and T1/DIA or T1/D1B is quite poor and performance over N2 carrier systems is marginal. Performance from two-wire locations appears to be about the same as that from four-wire locations when care is taken to match the modem impedance to reduce reflections.

Operations at lower bit rates (8 kb/s and 9.6 kb/s) appeared to be good from a statistical viewpoint on most calls that could not support 16 kb/s operation. Although this does not indicate that good operation at these rates could be expected over all access line conditions it does tend to argue for a 8 kb/s CVSD backup mode in the 16 kb/s modem which could be used for emergency conditions and could be provided at very little additional cost once a 16 kb/s system is deployed.

The quantity of data taken on the DDD network was insufficient to draw numerical conclusions with confidence. However, in general the data tended to support the argument that the DDD performance, like the Autovon performance will depend principally upon the type of access line and will provide generally an acceptable operation over the network when good access lines are available.

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D1B

T1/D1A

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EVALUATION

There is a significant need within the Department of Defense for improved quality narrowband secure voice communications. A number of voice encoding techniques capable of effecting the needed improvement are presently under study and evaluation; one such technique is 16 kb/s Continuously Variable Slope Delta Modulation (CVSD). The principal purpose of this test program was to assess the capability of the RADC developed 16 KB/S Modem to transmit 16 kb/s CVSD encoded digital voice signals over the CONUS AUTOVON Network. Results achieved clearly indicate that the 16 KB/S Modem can achieve the level of bit error rate (BER) performance necessary to support high quality secure voice communications on a large percentage of dial-up AUTOVON circuits. Data gathered during these tests supplements and reinforces test data obtained in earlier field test efforts conducted under contract F30602-75-C-0129 and contract F30602-76-C-0460 which evaluated 16 KB/S Modem performance over both AUTOVON and commercial telephone circuits in the CONUS, Europe and Pacific areas. It is felt that sufficient basis has been established by these tests to justify continued development and production of the 16 KB/S Modem. It has been clearly demonstrated that the 16 KB/S Modem, operating in conjunction with a suitable CVSD device, has high potential for satisfying important DoD secure voice transmission needs.

Salvatore J. Nasci

SALVATORE J. NASCI
Project Engineer

SECTION 1.0

SUMMARY

1.0 SUMMARY

A test program was conducted for the purpose of evaluating performance of a Rome Air Development Center (RADC) developed 16 kb/s Modem operating over the CONUS Autovon network. The objectives were to:

- Validate for CONUS Autosevocom II Application
  - o o Bellfield Configuration
  - o o Tenley Configuration
- Evaluate 16 kb/s Modem performance
  - o o CONUS Autovon
  - o o Direct Distance Dialing (DDD) System
  - o o Federal Telephone System (FTS)
- Conduct Additional tests at 9.6 and 8 kb/s
- Provide results to OASC/C^3I by 8 May 78

Measurements were made with the modems operating in a full-duplex configuration over four-wire Autovon connections and in a simplex configuration over two-wire Autovon connections. In addition to the 16 kb/s measurements, tests were conducted at 8 kb/s using the RADC developed modems and at 9.6 kb/s using a commercial 9.6 kb/s modem. Some simplex tests on the commercial DDD network were also made. Although tests over FTS were desired, time constraints of the program prohibited accomplishment of this task.

In all, 1425 calls were placed in which bit-error rate (BER) performance was measured. Nine different CONUS subscriber locations were involved. In addition to normal calls between modems located at different subscriber locations, loop-around calls were placed to most of the network switches.

The general results indicate that if the access line from the subscriber location is a "good" one the 16 kb/s modem is capable of providing BER values less than 1 percent on over 90 percent of the randomly dialed lines even when five switches are involved in a call. This condition has less than a 6 percent probability of occurring in a worstcase emergency condition. This will be discussed in more detail in section 2.1.1. The "good" access lines appear to be those which do not involve N carrier or the early version of T carrier systems (those involving D1A or D1B channel banks). Sixteen kilobit performance over N1 carrier systems and T1/D1A or T1/D1B is quite poor and performance over N2 carrier systems is marginal. Performance from two-wire locations appears to be about the same as that from four-wire locations when care is taken to match the modem impedance to reduce reflections.

Operations at lower bit rates (8 kb/s and 9.6 kb/s) appeared to be good from a statistical viewpoint on most calls that could not support 16 kb/s operation. Although this does not indicate that good operation at these rates could be expected over all access line conditions it does tend to argue for a 8 kb/s CVSD backup mode in the 16 kb/s modem which could be used for emergency conditions and could be provided at very little additional cost once a 16 kb/s system is deployed.

The synchronization capability of the 16 kb/s moden was excellent which is consistent with observations made in previous test programs. On 1434 recorded synchronization trials 97.7 percent were successful. Although, the synchronization data on the 9.6 kb/s modem was not as complete it is interesting to note that on the calls that 9.6 kb/s data was recorded the

synchronization performance of 16 kb/s modem was superior to that of the 9.6 kb/s modem. Specifically, 83.7 percent of 9.6 kb/s synchronization trials were successful whereas 97.1 percent of 16 kb/s trials on the same calls were successful.

The quantity of data taken on the DDD network was insufficient to draw numerical conclusions with confidence. However, in general the data tended to support the argument that the DDD performance, like the Autovon performance will depend principally upon the type of access line and will provide generally an acceptable operation over the network when good access lines are available.

1.1 Scope of the Test Program

The 16 kb/s CONUS test program was divided into four ph... In Phase I eight sites were visited during a two-week period from 13 to 24 March 1978. The eight sites involved were:

1) The Pentagon, Arlington, Virginia
2) Fort Meade, Maryland
3) Offutt Air Force Base, Omaha, Nebraska
4) Cheyenne Mt. Complex, Colorado Springs, Colorado
5) McChord Air Force Base, Tacoma, Washington
6) Vandenberg Air Force Base, Santa Rosa, California
7) March Air Force Base, Riverside, California
8) MacDill Air Force Base, Tampa, Florida

These sites were chosen as representatives of locations which might require a large amount of secure voice service if the present network secure voice network connectivity were increased. The objectives of visiting these sites were two-fold. One was to gather data on a larger set of access

lines than would be available from more thorough tests to be run during phase II and to identify what type of access lines were available. The second was to select three locations from which to conduct the phase II tests.

A 16 kb/s modem was taken on the site survey and 305 calls were placed which included 125 calls between the site and the Harris plant in Melbourne, Florida, where a second modem was present. The remaining 180 calls were loop-around calls usually over the Autovon network from the site in question. In nearly all cases, five measurements of bit-error-rate (BER) were made, each measurement involving 160,000 bits. The bit error rates presented in this report represent the median of the five recorded values. In most cases, however, the span of error rates involved in the five measurements was relatively small. If the errors were statistically independent from bit-to-bit on a channel with a true 16 kb/s BER value of 1 percent, the probability of a measured error rate more than 10 percent away from the correct value is less than 4×10^{-5}. Hence one would expect to see all five values between 0.9 percent and 1.1 percent. Although this level of accuracy is observable on many of the sets of measurements, variations in the channel and the effect of modern training tends to increase the range of measured values.

In calls involving two separate modems, such as those from the site to Melbourne, it was usual to record BER values existing at each end of the link. The 3 kHz channels used in each direction are not identical, and the error rates received at each end on a given call are usually not the same and often differ substantially. In many of the curves presented in this section, BER values at both ends of a single call were used to determine the BER statistics displayed.

The term "connection" will be used to indicate a single 3 kHz transmission from a modem transmitter to a modem receiver in which BER values were recorded. Thus, calls involving two modems usually resulted in two connections. Four-wire loop-around calls, however, involved only one connection. During the site survey BER values were recorded in 413 connections.

The second phase of the program involved one week of tests from each of three sites selected during the site survey to either the Pentagon or Fort Meade. This phase was conducted from 3 to 21 April 1978. The first week of tests was conducted from MacDill Air Force Base to the Pentagon. The second week involved tests from Offutt Air Force Base to the Pentagon. During the third week, tests were conducted from March Air Force Base to both Fort Meade and the Pentagon. In addition, calls were placed from March Air Force Base to Melbourne, Florida. In all, 373 calls involving 659 connections were completed during Phase II. These consisted of 111 loop-around calls and 262 other calls.

The third phase of the test program involved measurements made on the NSA wire line simulator at Ft. Meade. These tests were conducted over a two-day period (26 and 27 April 1978) using the same modems used during the field test phases. The modems were tested for BER under 20 different simulated channel conditions.

In addition to the recordings made during the first three phases of the test program, a large number of measurements were made from the contractor's site prior to the commencement of the formal test program. These recordings consisted of 417 loop-around calls placed on the four-wire

Autovon phones in Melbourne, Florida, on 17, 19 and 20 February 1978. The purpose of these tests was to obtain data that would be useful in planning the field tests. Subsequent to the field tests an additional 120 loop-around calls and 210 dial-through calls involving both modems used in the field tests have been conducted. These calls were placed on 12, 22, and 25 May 1978. As will be demonstrated, the additional data obtained from the Melbourne site is extremely useful in allowing a better understanding of the data obtained in all of the other three phases of the test program and is presented also in this report. The Melbourne data involved 747 calls and 957 connections. This effort will be called Phase IV in the report. Phase IV data was not witnessed by government personnel; however, they were coordinated with the test director and it was agreed that this data would provide insight into the performance of the modems.

<u>In summary, the results presented in this section of the report are based upon data gathered on 1425 separate calls and 2029 connections.</u>

1.2 Type of Calls

In general, the calls were either placed on the CONUS Autovon system or on the commercial DDD network. In the case of the Autovon tests, the calls can be categorized as:

1) Normal four-wire calls
2) Normal two-wire calls
3) Dial-through four-wire calls
4) Dial-through two-wire calls
5) Looped four-wire calls
6) Access loops (four wire)
7) Access loops (two wire)

The "normal" calls are defined as long distance calls from one subscriber location to another. In the case of four-wire normal calls, the modems are either connected to an Autosevocom access line, a four-wire subscriber access line or to a four-wire point on a general purpose access line going to a two-wire PBX. The normal two-wire calls involved calls where the modem was connected on the subscriber side of a two-wire PBX. These calls accessed the Autovon network via general purpose four-wire access lines connecting the PBX with an Autovon switch. Both two-wire and four-wire normal calls were directly dialed from one of the two subscriber locations to the other. Thus, the routing of these calls should have been representative from a statistical viewpoint, of the normal routing achieved in the network between the two subscriber locations involved. In a few cases two PBX's are involved in a call before an Autovon switch is reached. This situation existed in several calls which were placed from Fort Meade during phase one.

The dial-through calls utilized special dial-through numbers that were assigned to nine Autovon switches. These switches were:

1) Yakima, Washington
2) Seguin, Texas
3) San Luis Obispo, California
4) Pottstown, Pennsylvania
5) Norway, Illinois
6) Drainsville, Virginia
7) Arlington, Virginia
8) Moseley, Virginia
9) Jasper, Alabama

The dial-through procedure was to dial the Autovon dial-through number for one of the nine switches. This would result in a normal connection with normal routing between the subscriber location and the Autovon switch. The dial-through number would then provide a dial tone allowing a second number to be dialed as if the caller were a subscriber to that switch. The second number could either be another dial-through number or a second subscriber. Thus, as many of the nine switches as desired could be "dialed through" on the way to reaching the second subscriber. The dial-through calls were intended to force alternate routings which might exist in an emergency condition. It should be emphasized, however, that the routings involved in dial-through calls guarantee only that the call goes through the dial-through switch and does not guarantee anything about the routings to and from that switch. Thus, a "single" dial-through call from Melbourne to the Pentagon via the Jasper switch has no guarantee of going through exactly three Autovon switches. (Polk City for Melbourne; Jasper and Arlington for the Pentagon.) Additional switches may be picked up on either or both legs if the direct trunks from Polk City to Jasper or Jasper to Arlington are busy. A dial-through from Melbourne to the Pentagon via the Norway switch is guaranteed to involve at least four switches since there are no direct trunks from Polk City to Norway. The significance of the number of switches involved in a call will be discussed later. The dial-through calls, like the normal calls, were placed from either four-wire access points or two-wire access points.

The four-wire loop-around calls were made to special loop-around numbers at an Autovon switch from a four-wire access point. The loop-around numbers cause the transmit pair to be connected to the respective receiver

pair of the four-wire circuit at the switch in question. Hence, the modem receives its own transmitted signal at the four-wire subscriber location. The routing to the loop-around switch is normal, but the routing to and from the switch is the same. Most of the 60 CONUS Autovon switches have automatic loop-around capability. Loop-around calls of this nature cannot be placed from a two-wire subscriber location since both transmit and received signals would then appear simultaneously on the same ports.

The four- and two-wire access loops involved loop-around calls from a subscriber to either the local Autovon switch assigned to that subscriber line or to a subsidiary switch such as a PBX which exists between the subscriber and the Autovon switch. In the case of two-wire loops, 2 two-wire connections are used and one number is dialed from the other using either an Autovon prefix or not depending upon the nature of the desired loop. In the case of four-wire access loops, the calls can be placed to the automatic loop-around number for the Autovon switch assigned to the subscriber or the loop-around can be effected manually by requesting a patch between transmit and receive at that switch. In a few cases 2 four-wire circuits were available and loops were achieved by dialing through the local switch. In some cases four-wire access loops were tested which were not a part of the Autovon network but were a part of the DCS. These we _ selected because they involved a particular type of transmission facility that might be found on Autovon circuits at other locations. These circuits were not used on any other type of call, however.

The commercial calls were placed over the commercial DDD network by dialing a second subscriber from the first. Calls placed from on-base locations usually involved dialing off-base and placing a credit card call to

the other subscriber. Some off-base calls were placed, as well, to Melbourne during Phase I in which case direct dial was normally employed. All of these calls were, of course, two-wire calls. In a few cases, local commercial loops were tested between 2 two-wire phones with DDD access.

Table 1.2 shows a breakdown of calls placed during Phases I, II and IV of the test program. The miscellaneous category includes commercial loop-around calls and some four-wire loop calls placed to the Airborne Command Post during Phase I. The normal and dial-through calls during Phase I were placed between the location shown and Melbourne, Florida. All loop calls were placed at the location shown. The normal and dial-through calls during Phase II were placed between the top location listed and the location with the number. Thus, there were 14 normal four-wire calls placed between MacDill and the Pentagon and 13 normal two-wire calls between March and Melbourne. Cases in which dial-through calls are listed for March are cases where long distance dial-through calls were made from March to Melbourne. The loop-around calls are listed for the location shown. All Phase IV calls were placed from Melbourne. The dial-through calls were placed on a four-wire Autovon phone in Melbourne, Florida, to the other four-wire Autovon phone in Melbourne.

1.3 Types of Measurements

The principal emphasis in the program was evaluation of the 16 kb/s modem on the CONUS Autovon network. Hence, the bulk of the measurements made were simply error rate performance of this modem. As previously discussed, these measurements consisted of five 100,000 bit counts of errors. However, a number of other types of measurements were recorded and will be presented in this report.

Table 1.2. Test Program Phases I, II and IV Breakdown

TYPE OF CALL	Normal (4 wire) Number of Calls	Normal (4 wire) Number of Comm.	Normal (2 wire) Number of Calls	Normal (2 wire) Number of Comm.	Dial-Through (4 wire) Number of Calls	Dial-Through (4 wire) Number of Comm.	Dial-Through (2 wire) Number of Calls	Dial-Through (2 wire) Number of Comm.	Long-Distance Loops (4 wire) Number of Calls	Long-Distance Loops (4 wire) Number of Comm.	Access Loops (4 wire) Number of Calls	Access Loops (4 wire) Number of Comm.	Access Loops (2 wire) Number of Calls	Access Loops (2 wire) Number of Comm.	Comm. DDD Number of Calls	Comm. DDD Number of Comm.	Miscellaneous Number of Calls	Miscellaneous Number of Comm.
Phase I																		
Pentagon	5	10	0	0	0	0	0	0	17*	17*	6	6	0	0	0	0	0	0
Ft. Meade	0	0	2	2	0	0	0	0	0	0	0	0	3	3	7	9	8	8
Offutt AFB	20	39	0	0	4	8	0	0	20	20	6	6	0	0	1	1	3	3
Cheyenne Mt	21	41	0	0	4	8	0	0	26	26	4	4	0	0	2	4	0	0
McChord AFB	7	14	1	1	0	0	0	0	14	14	6	6	0	0	9	16	0	0
Vandenberg AFB	6	12	0	0	0	0	0	0	16	16	3	3	0	0	4	6	0	0
March AFB	6	12	5	10	0	0	0	0	19	19	3	3	0	0	8	14	0	0
MacDill AFB	5	10	1	2	2	4	0	0	21	21	5	5	0	0	5	10	0	0
305/413	70	138	9	15	10	20	0	0	133	133	33	33	3	3	36	60	11	11
									305/413									
Phase II																		
McDill			45	82					0	0	0	0	10	10				
Pentagon	14	28	45	82	3	6	9	17	0	0	0	0	37	73	5	9	0	0
					p-p 7	12												
Offutt									0	0	4	4	5	5				
Pentagon	8	15	43	84	6	11	26	48	0	0	0	0	9	12	17	34	0	0
March							8	8	0	0	0	0	17	17				
Ft. Meade	0	0	11	21	0	0	2	4	0	0	0	0	21	34	4	8	2	3
Melbourne	0	0	13	24	0	0	22	43	0	0	0	0	0	0	0	0	0	0
Pentagon	0	0	10	19	0	0	6	12	0	0	0	0	0	0	10	20	0	0
373/659	22	43	125	235	9	17	72	132	0	0	4	4	103	155	36	71	2	3
									373/659									
Phase IV																		
Melbourne 747/957	0	0	0	0	210	420	0	0	527	527	10	10	0	0	0	0	0	0
									747/957									
TOTAL 1425/2029	92	81	134	250	229	457	72	132	660	660	47	47	106	158	72	131	13	14

* Nine of these dial-through calls were judged to be unusable due to echo suppressor problems.

During Phase I a Halcyon transmission line test set was taken on the site survey along with a 16 kb/s modem. In cases where error rates were poor, the Halcyon was used to diagnose the cause. Generally, however, only the parameters which were assessed as affecting performance were recorded. During Phase II the procedure was to take a more complete set of Halcyon measurements on calls where the 16 kb/s error rate exceeded 1 percent. Again, however, the intent was to identify the cause of BER rather than to obtain general purpose line data. In addition, the commercial 9.6 kb/s modems were supplied and error rate measurements were made at this rate and 8 kb/s on the 16 kb/s modem on calls where the 16 kb/s error rate exceeded 1 percent. The BER values obtained on the commercial 9.6 kb/s modems were derived from five 10-second counts of errors. The 8 kb/s BER values, like the 16 kb/s BER values were obtained from five 100,000 bit counts. In almost all cases during Phase II, two syncs were sent at a particular rate. The formal BER measurement was made on the second synchronization if the first sync was successful. If it was not, further syncs were sent until two consecutive successful syncs were achieved or ten syncs were tried. There were no cases where ten syncs were needed to be tried. In Phases I and IV error rates were recorded on the first sync signal. Sync signals were repeated only if the first sync was not successful. In Phase IV the error rate was recorded as 50 percent if the second sync was not successful.

On approximately every tenth call in Phase II a tape recording was made of 16 kb/s voice operating through an HY 11, 16 kb/s, CVSD voice digitizer and the 16 kb/s modem. In addition, the call was left up for 5

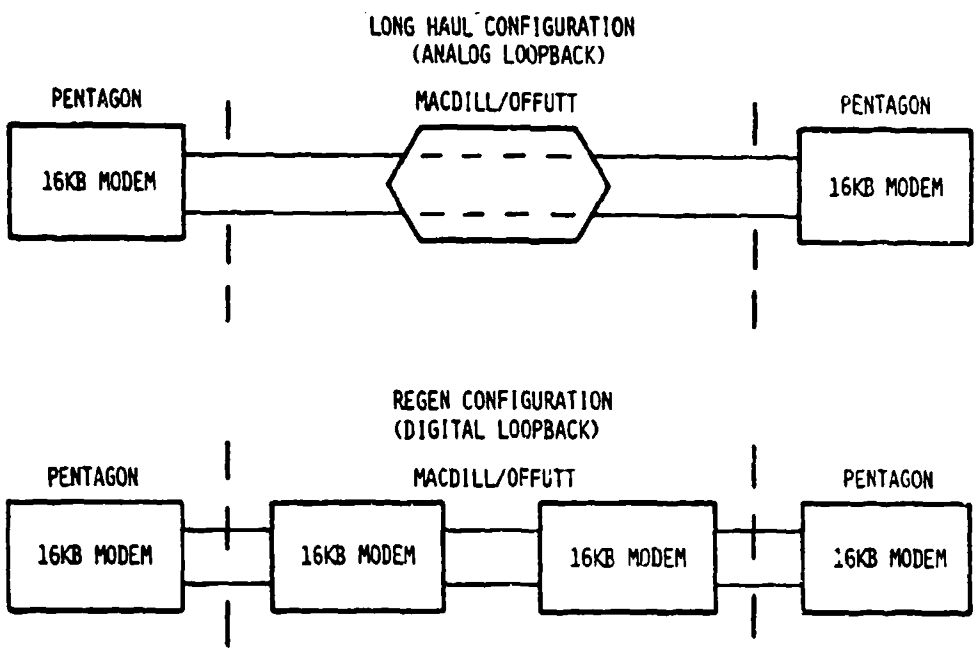


Figure 1.3-1. Digital Tandeming Configuration

minutes and error rates recorded at the beginning and end of the call. In some cases voice recordings were made on calls selected for high error rates rather than or in addition to the tenth call.

The modems used during Phase II were equipped with the capability of digitally regenerating signals that were received and retransmitting them from its transmitter. In most of the normal four-wire and dial-through calls of Phase II, error rates were recorded when such a "digital loop back" existed as well as an analog loop back from the same modem. This data indicates the type of performance available if regenerators were to be supplied on the network. Figure 1.3-1 shows the configuration for an analog and digital loop back from the Pentagon to either Offutt or MacDill.

SECTION 2.0

PRESENTATION OF DATA

2.0 PRESENTATION OF DATA

The presentation of the test results will be divided into three paragraphs. In Paragraph 2.1, the reduced data for the four-wire calls will be given. In Paragraph 2.2, the reduced data concerning the two-wire calls will be presented. Paragraph 2.3 will consider the results of the NSA simulator tests. In addition to these sections, a number of appendices will be included. These appendices will present the recorded data on all calls. Appendix A will present the data gathered in Phase IV. Appendix B will present the data gathered in Phase I. Appendix C will present data gathered in Phase II. Appendix D presents a draft of a test plan developed by a a test committee. This plan was used as a guide for the program. Appendix E presents measured data taken on the modems prior to and after the test program.

In order to better assess the meaning of the BER value presented it worth noting that 1 percent or smaller BER values represent very little loss in voice quality at 16 kb/s over the quality available on a noise-free link. At 2 percent BER, the link noise is noticeable but not so bad as to seriously effect the conversation. At 5 percent BER the conversation is understandable but the noise is definitely objectionable. At 10 percent BER the system would generally be judged to be unusable although a request to hang up and call back would likely be understood. Although this description is admittedly subjective in nature it should provide a ball park basis for those who have not had direct experience in listening to 16 kb/s CVSD at various BER values.

2.1 Four-Wire Results

As was indicated in Table 1.2 there were 92 normal four-wire calls placed during the test program resulting in 181 connections in which BER values were recorded. These calls were placed between nine different pairs of locations. Figure 2.1-1 is a histogram of the BER values of these 181

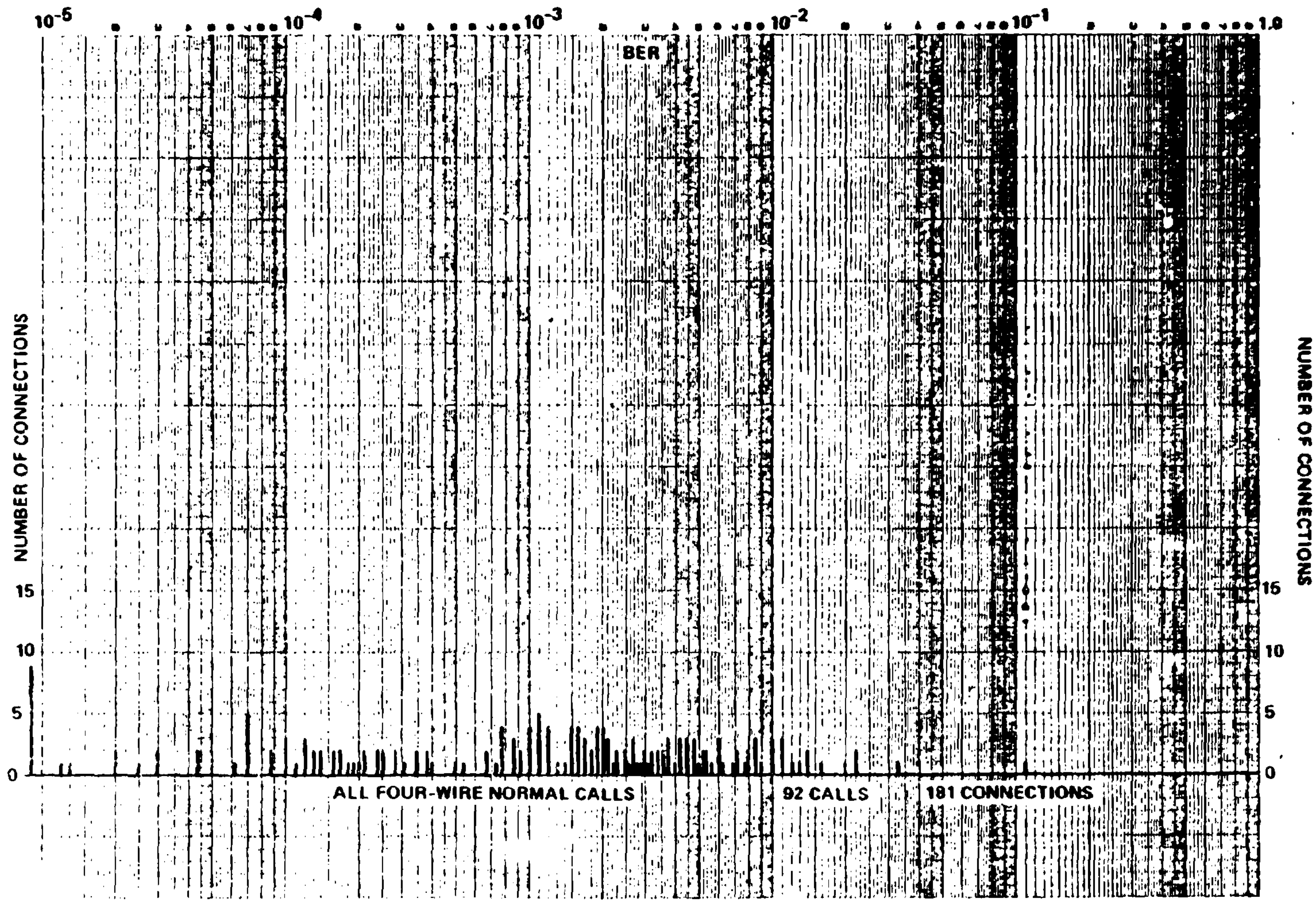


Figure 2.1-1. Normal Four-Wire Calls Histogram

connections. Figure 2.1-2 shows the percent of connections in which the BER value was equal to or better than a particular value. Thus, on 93 percent of all connections,the BER was equal to or better than 1 percent and 99 percent of the connections had a BER value of 2.3 percent or better. The median BER value was 0.15 percent.

If one could argue that these calls were representative of calls from any place in the network as it might exist for an emergency condition for Autosevocom II, then Figure 2.1-2 would represent all of the required data for four-wire connections. Although the data presented in Figure 2.1-2 is certainly more representative of the network than could be obtained from a smaller number of calls from a smaller number of locations, it would be presumptuous to claim that it is representative of a network as vast as the CONUS Autovon network. Indeed it is likely that any test program aimed at obtaining such a representative sample would be unlikely to be executable in a reasonable time and cost frame.

In order to properly interpret the data gathered, several points should be remembered.

1. The CONUS Autovon network consists of 60 Autovon switches serving a far larger number of subscriber locations, many with PBX facilities. The switching rules for the network are complex to help assure survivability. This, however, makes it difficult to determine call routing and also implies that an extremely larger number of routines are feasible from any two locations.

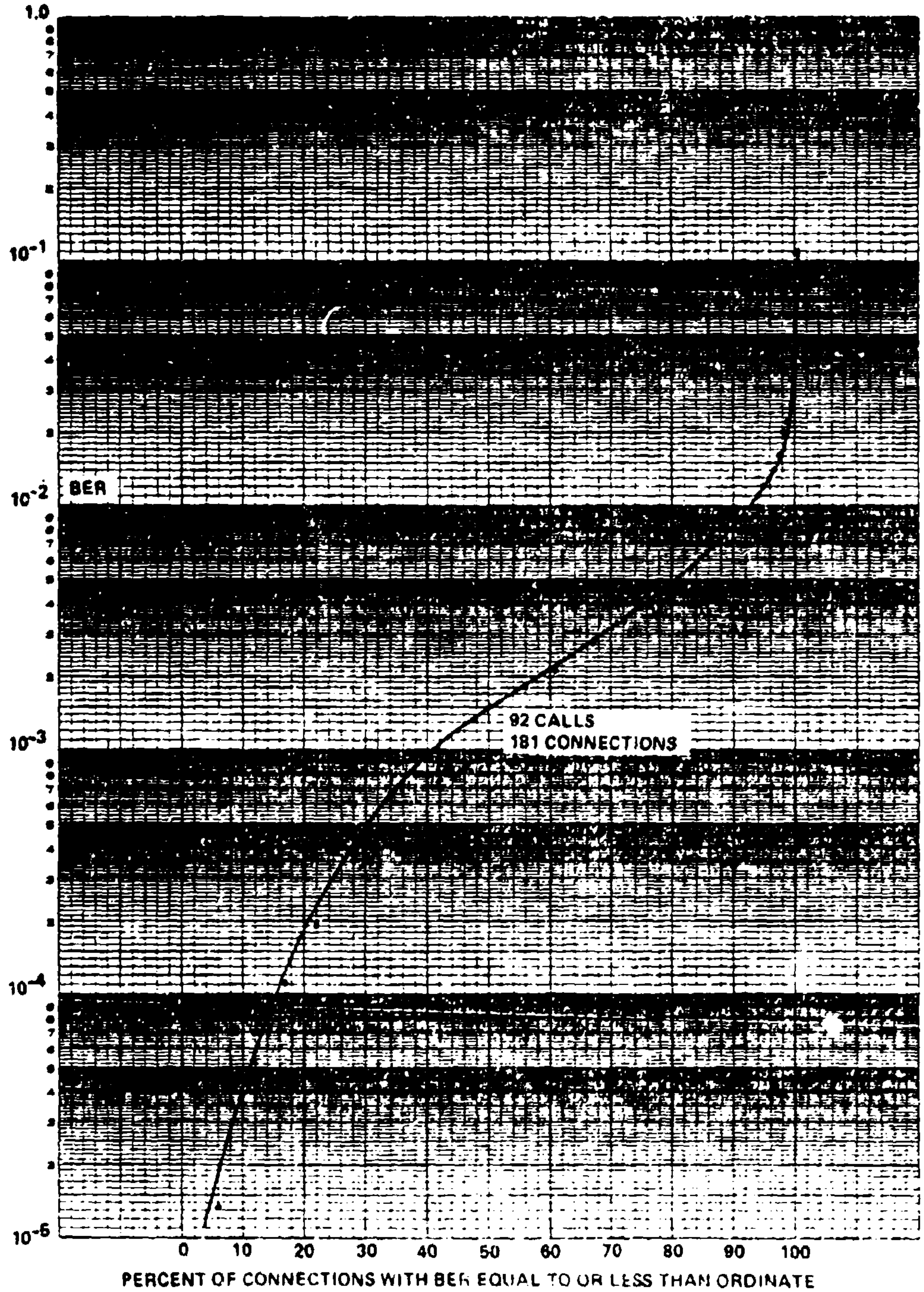


Figure 2.1-2. Normal Four-Wire Calls - Cumulative Probability

2. The quality of a call from a particular subscriber location to another in the network will depend upon the quality of the access lines interfacing the network from the subscriber location as well as the quality of the particular Interswitch Trunk (ISTs) being used in that call. Whereas, the IST quality may vary widely from call to call, the access line quality will likely vary much less since a much smaller choice of access lines usually exist and often these lines transit the same type of transmission facilities.

3. An average error rate curve, such as that shown in Figure 2.1-2 is questionable even if the subscriber locations are representative of those in the network in terms of access line quality. If each subscriber location, regardless of access line quality, could achieve a connection probability of error as shown on the curve on each dial, the curve would be meaningful. However, it is apparent that a few locations with bad access lines could exist which would always provide bad error rates but which occur with small enough frequency in the network to allow a curve such as that shown when the performance is averaged over all subscriber locations. Implementation of the network, including these locations, with the modem, however, would be foolish since no satisfactory calls could be placed to or from these locations. It is obvious that either the access lines to these locations would have to be improved or some alternate technique would have to be supplied to allow communications to these locations. Thus,

the right question to ask is: What types of access lines allow satisfactory operation over the network and what would be involved in upgrading the types, if any, that were not satisfactory?

4. Finally, the question of satisfactory operation over the network from a particular type of access lines cannot be completely resolved by making multiple calls over these lines. This is due to the fact that satisfactory operation over the peacetime network is not sufficient. Satisfactory operation over a network which has been damaged is also a requirement.

To address the questions presented here with the available data, two steps are necessary. First, the question of satisfactory operation over a damaged network must be examined. This is best addressed by choosing one particular access line type and placing many calls over the network. The calls from Melbourne gathered in Phase IV meet this requirement. Then data taken from different types of access lines needs to be examined in this light to establish what type of access lines, if any, might be unsatisfactory. Hence, the data gathered in Phase IV will first be presented.

2.1.1 Phase IV Test Results

The Phase IV test consisted of a large number of loop-around and dial-through calls placed from 2 four-wire Autovon lines which had previously been installed at the contractor's facility in Melbourne, Florida, to aid in 16 kb/s modem testing. Since these phones are direct subscribers to the Autovon switch in Polk City, Florida (about 80 miles from Melbourne) the same two access lines were used in all of these calls, hence, removing the variable of different access lines. Loop-around calls were placed to 42 of the 60 Autovon switches. A minimum of ten calls were placed to each switch with half

of the calls placed from one access line and half from the other. In loops to many of the switches, ten calls were placed during busy hours and ten calls were placed during off hours. In addition, 210 dial-through calls were placed using the nine available dial-through locations. These calls were placed from one of the Autovon phones to the other. The two modems used in Phases I, II and III of the field tests were used to record full duplex BER values in both direction of the dial-through calls.

Reduction of the Phase IV data indicates a remarkable degree of correlation between BER values obtained on a particular call and the number of switches involved and, hence, the number of baseband conversions involved in the call. Let us first examine the case where dial-through calls or loop-around calls were placed to switches which have direst IST connections to the Polk City switch. In this case, both types of calls involve two baseband conversion at the Polk City switch and one at the remote switch. These have been labeled as three switch calls. Figure 2.1.1-1 shows a histogram of BER values obtained from 50 loops and 50 dial-through calls to five such swithes. The calls were placed during off hours to minimize the probability of the direct trunks being busy. The switches selected were:

POL-SEG-POL	(Sequin, Texas)
POL-MOS-POL	(Moseley, Virginia)
POL-ARL-POL	(Arlington, Virginia)
POL-DRA-POL	(Drainsville, Virginia)
POL-JAS-POL	(Jasper, Alabama)

As can be seen, except for a few anomolous connections, the BER values were generally below 0.3 percent for both types of calls. In Figure 2.1.1-2 a histogram of loop-around calls and dial-through calls involving five switches (or baseband conversions) is shown. Again the calls were placed during

off-hours to reduce the probability of alternate routing. BER values from 70 loop-around calls representing loops to seven switches which require one intervening switch are shown. BER values from 60 dial-through calls (120 connections) involving six different dial-through routines are shown.

The switches involved were:

Loops	Dial Throughs
POL-X-POT-X-POL	POL-X-SLO-X-POL
POL-X-LIT-X-POL	POL-X-POT-X-POL
POL-X-NET-X-POL	POL-X-NOR-X-POL
POL-X-TOL-X-POL	
	POL-SEG-SLO-ARL-POL
POL-X-CHE-X-POL	POL-DRA-POT-MOS-POL
POL-X-SLO-X-POL	POL-JAS-NOR-DRA-POL
	POL-JAS-NOR-DRA-POL
POL-X-MOJ-X-POL	

The designation, X, represents a switch selected by the network from the most direct triple. In all cases at least three switches exist which have direct IST connection with both switches involved. In both loop-around and dial-through calls, the bulk of the BER values lie between 0.07 percent and 0.7 percent. Again some anomolous measurements occurred. Thus, the range of error rates involved in these calls have very little overlap with those involving a three switch call.

Figure 2.1.1-3 presents a histogram of seven switch loops and dial throughs. The loops, in this case, involved 40 calls to two switches and the dial throughs 70 calls involving seven routings. These calls were also run in non-busy hour. The switches involved were:

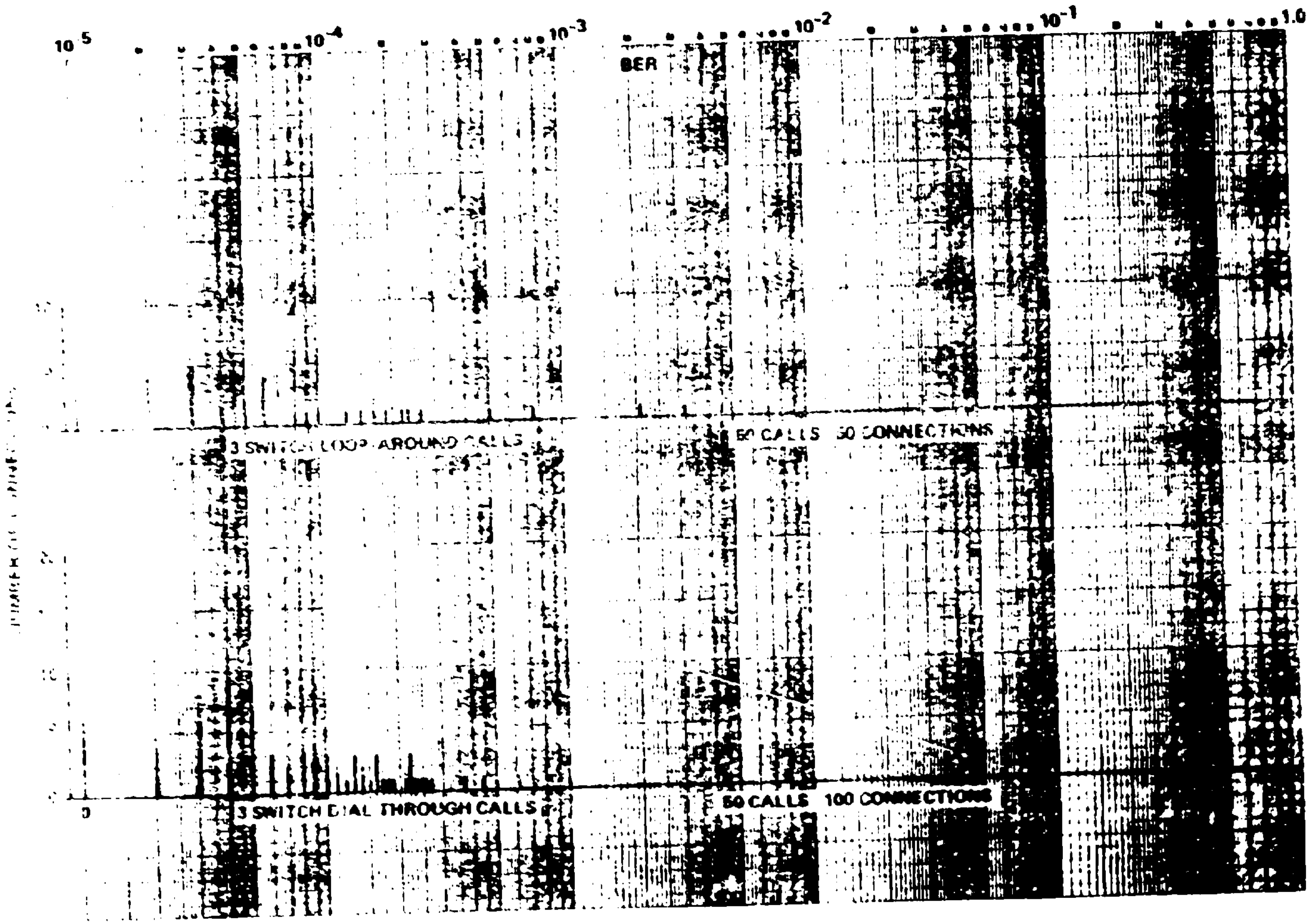


Figure 2.1.1-1. Three Switch Dial-Throughs and Loop (Non-Busy Hours)

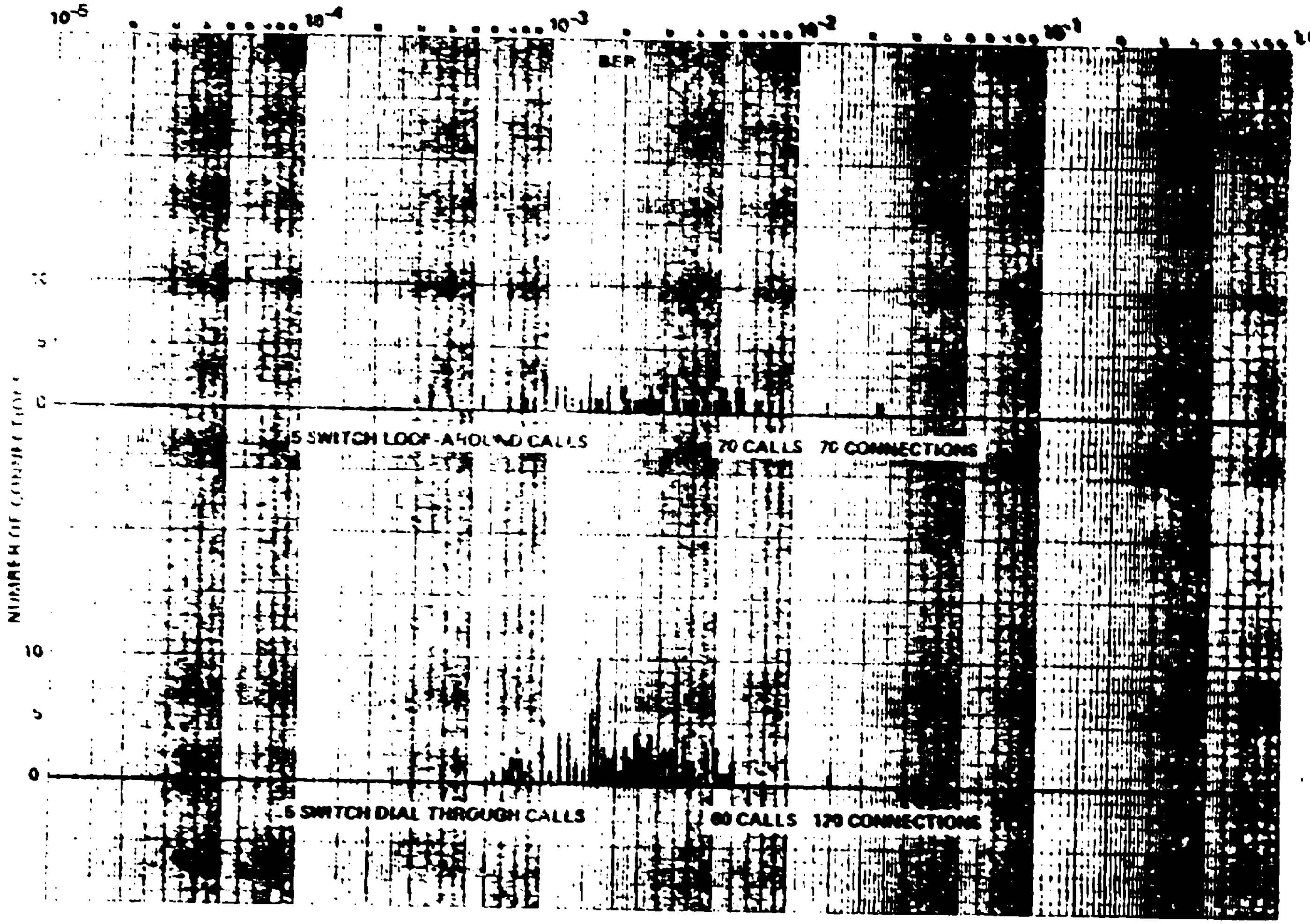


Figure 2.1.1-2. Five Switch Dial-Through and Loop-Around Calls (Non-Busy Hour)

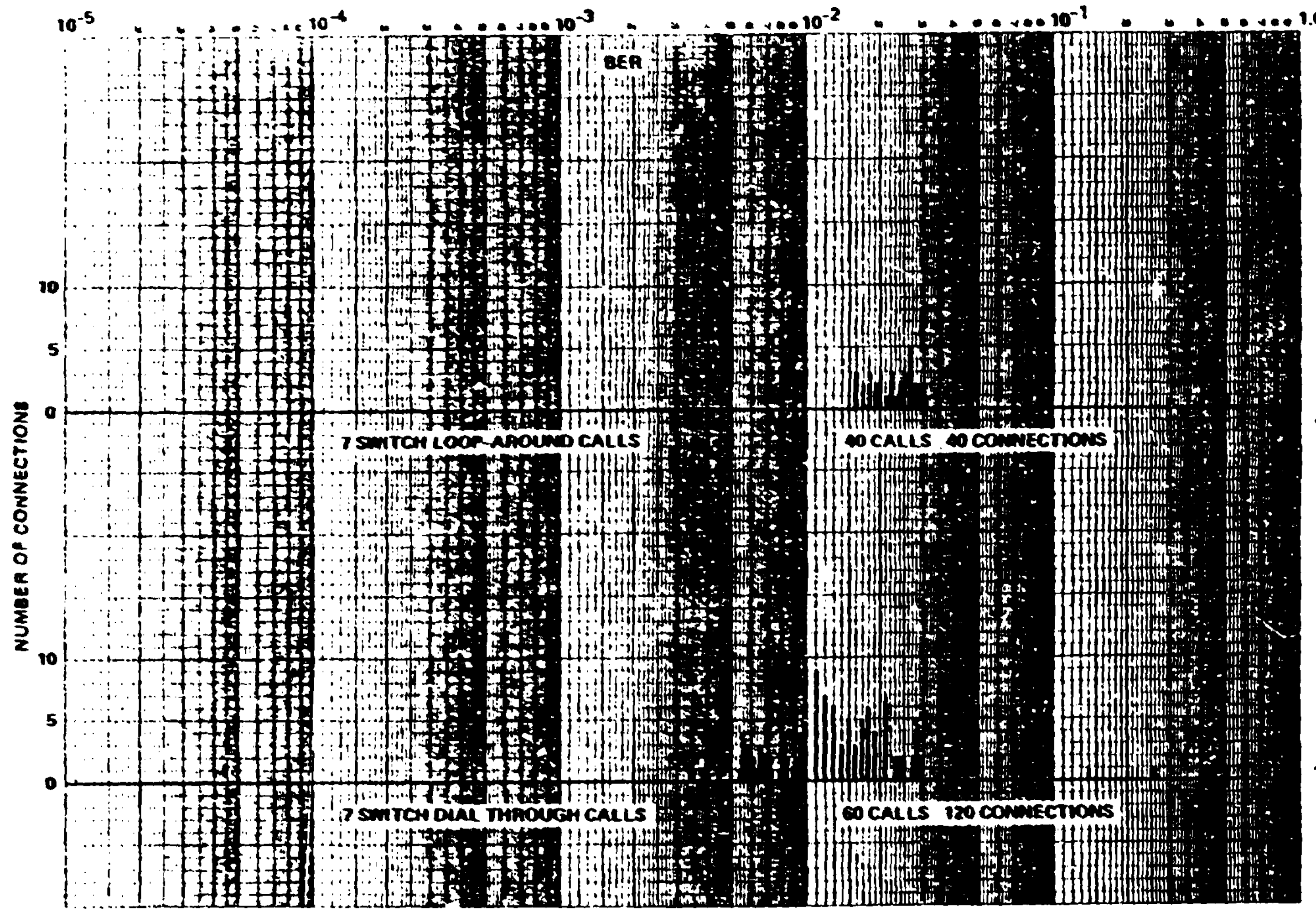


Figure 2.1.1-3. Seven Switch Dial-Through and Loop-Around Calls (Non-Busy Hour)

Loops	Dial Throughs
POL-X-X-SHE-X-X-POL	POT-X-SLO-X-POT-X-POL
POL-X-X-SMF-X-X-POL	POL-X-SLO-X-NOR-X-POL
	POL-X-POT-X-SLO-X-POL
	POL-X-NOR-X-POT-X-POL
	POL-MOS-X-SLO-X-JAS-POL
	POL-SEG-X-POT-X-JAS-POL

In the case of these seven switch calls, the loop-around values appear to be slightly worse than the dial-through values, but both sets have little overlap with the corresponding five switch BER values shown in Figure 2.1.1-2.

Figure 2.1.1-4 shows a set of nine switch dial-through calls. There were BER values from 20 calls involving two routings in this category. The routings were:

POL-X-POT-X-SLO-X-NOR-X-POL

POL-X-SLO-X-POT-X-NOR-X-POL

Althrough there is a slight overlap between BER values for seven and nine switch calls, there is no doubt that nine switch calls are worse.

Figure 2.1.1-5 shows the cumulative probability curves for the three, five and seven switch loop-around calls. Figure 2.1.1-6 presents similar data for the dial-through calls. Figure 2.1.1-7 shows the two sets of curves on the same sheet for comparative purposes. Several significant conclusions can be drawn from this data.

1. The 16 kb/s BER value is a strong function of the number of switches transited on a particular call.
2. The behavior on loop-around calls is remarkably similar to that on dial-through calls when the number of switches involved is the same.
3. The variation due to routing and distance differences on calls is less than that due to differences in the number of switches.

This last point can be illustrated better by Table 2.1.1-1. Here a number of three and five switch loop-around calls are listed along with the median BER of the ten calls to that switch. The air distance in miles involved in the loop from Polk City to the switch is also given. A "B" besides a switch indicates that the data was taken during busy hour. Otherwise the data was taken during non-busy hours.

Table 2.1.1-1. BER Versus Distance

	3 Switch Calls			5 Switch Calls	
Switch	BER (MED)	Dist (Miles)	Switch	BER (MED)	Dist (Miles)
B ELL	1.3-4	320	B CHY	4.3E-3	1460
JAS	0	1060	B WIL	1.4E-3	1500
MOS	2.5-4	1400	B LEE	4.3E-3	1640
B MEM	0	1440	POI	2.5E-3	1860
ARL	5.0-5	1580	TOL	1.1E-3	1900
DRA	2.0-5	1580	NET	3.5E-3	2000
SEG	1.1-4	1900	CHE	1.7E-3	2140
B SOC	1.0-4	3000	LIT	5.6E-3	2300
			MOJ	4.7E-3	4260
			B SLO	1.0E-3	4600

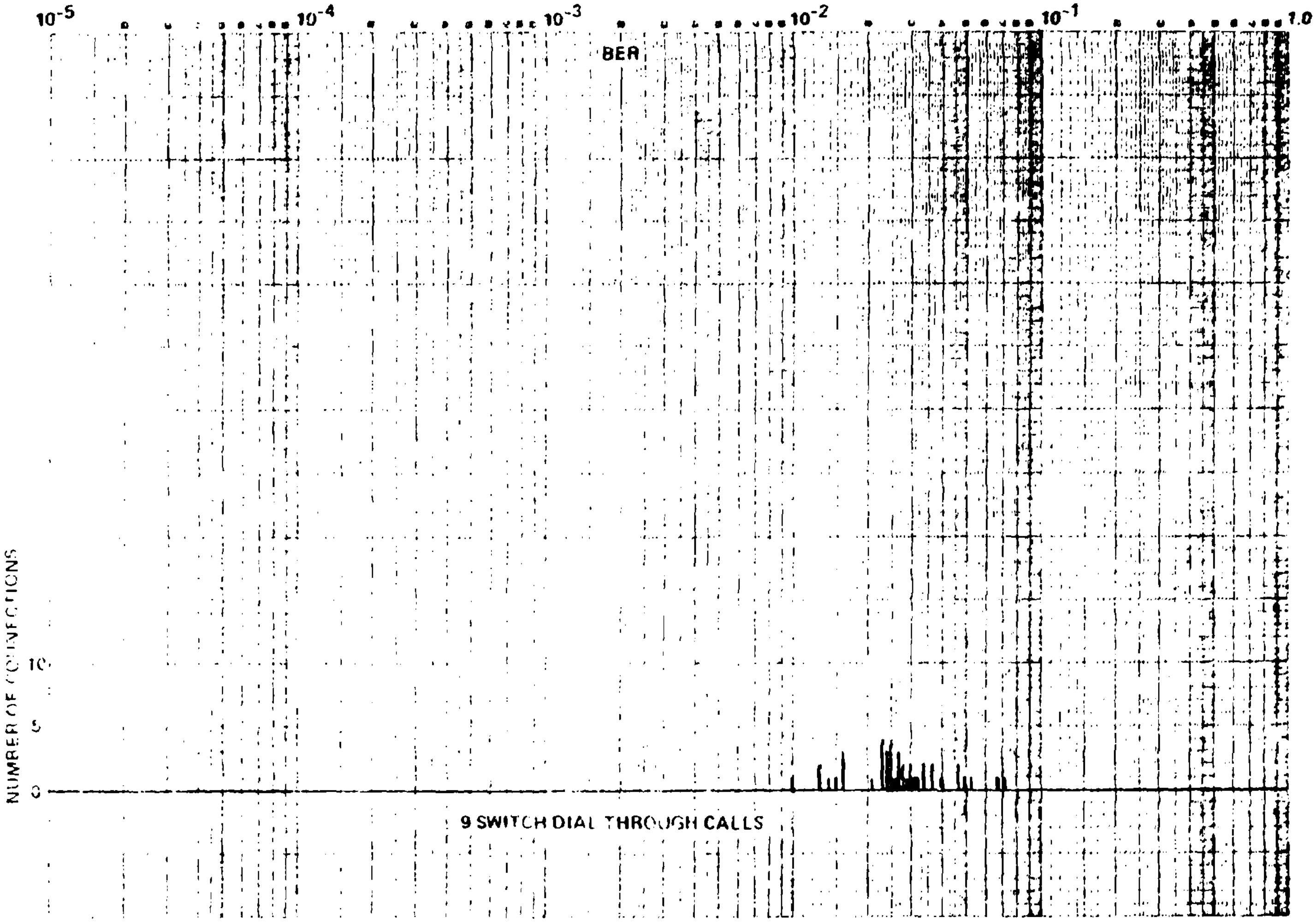


Figure 2.1.1-4. Nine Switch Dial-Through Calls (Non-Busy Hour)

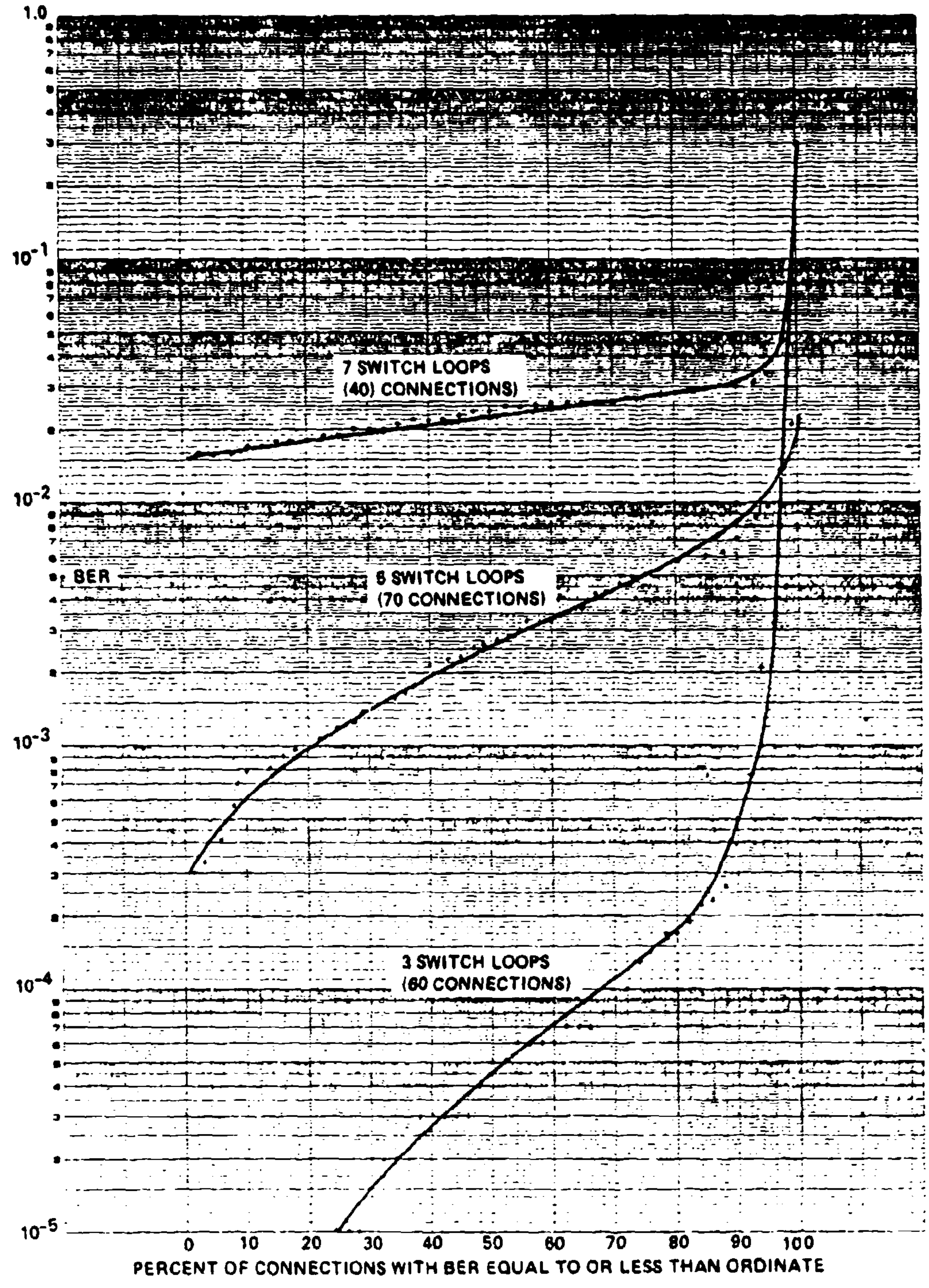
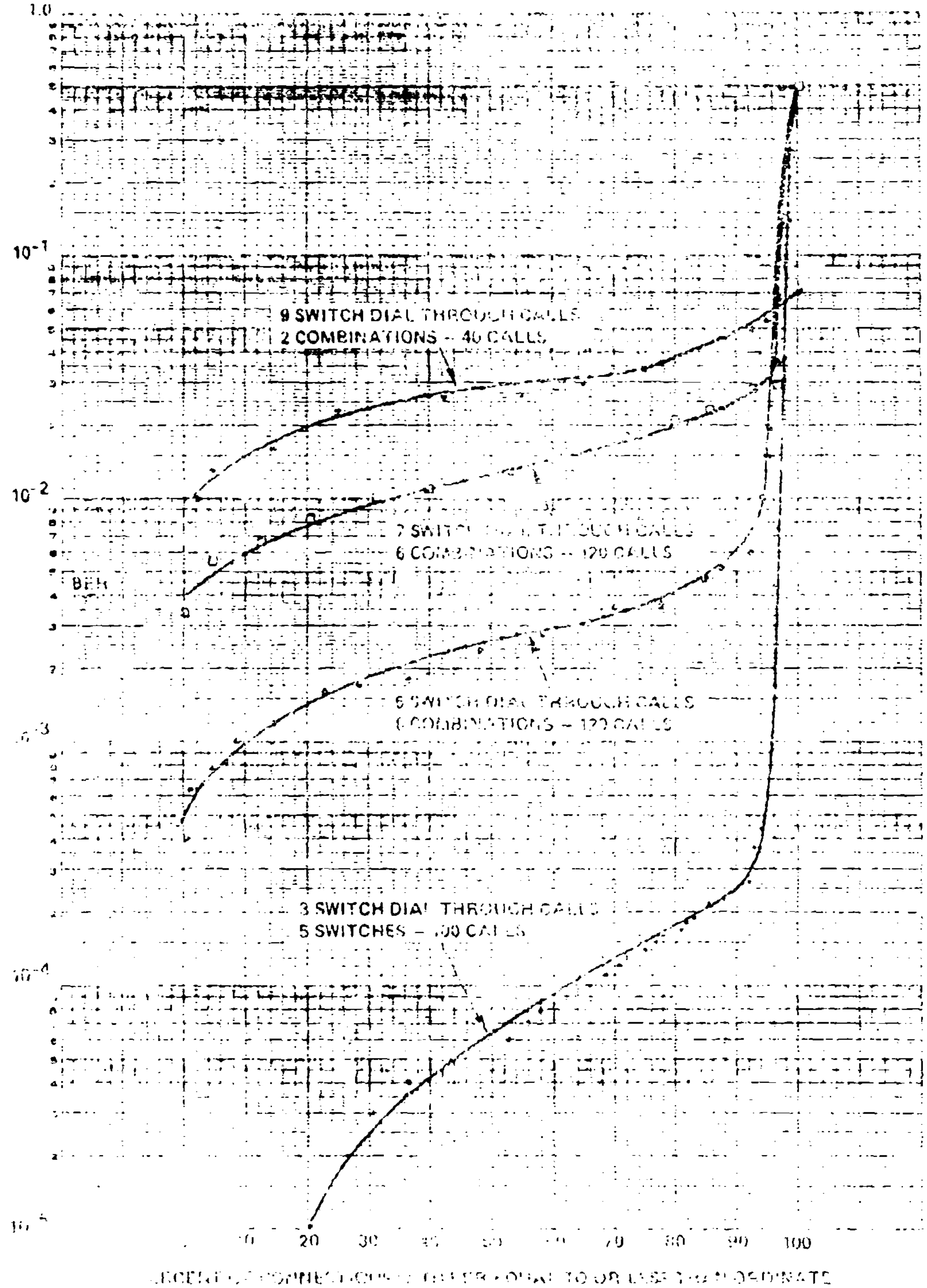


Figure 2.1.1-5. Loop-Around Calls From Melbourne During Non-Busy Hours



1.0
10^{-1}
10^{-2}
BER
9 SWITCH DIAL THROUGH CALLS
2 COMBINATIONS – 40 CALLS
6 COMBINATIONS – 120 CALLS
3 SWITCH DIAL THROUGH CALLS
5 SWITCHES
20
100

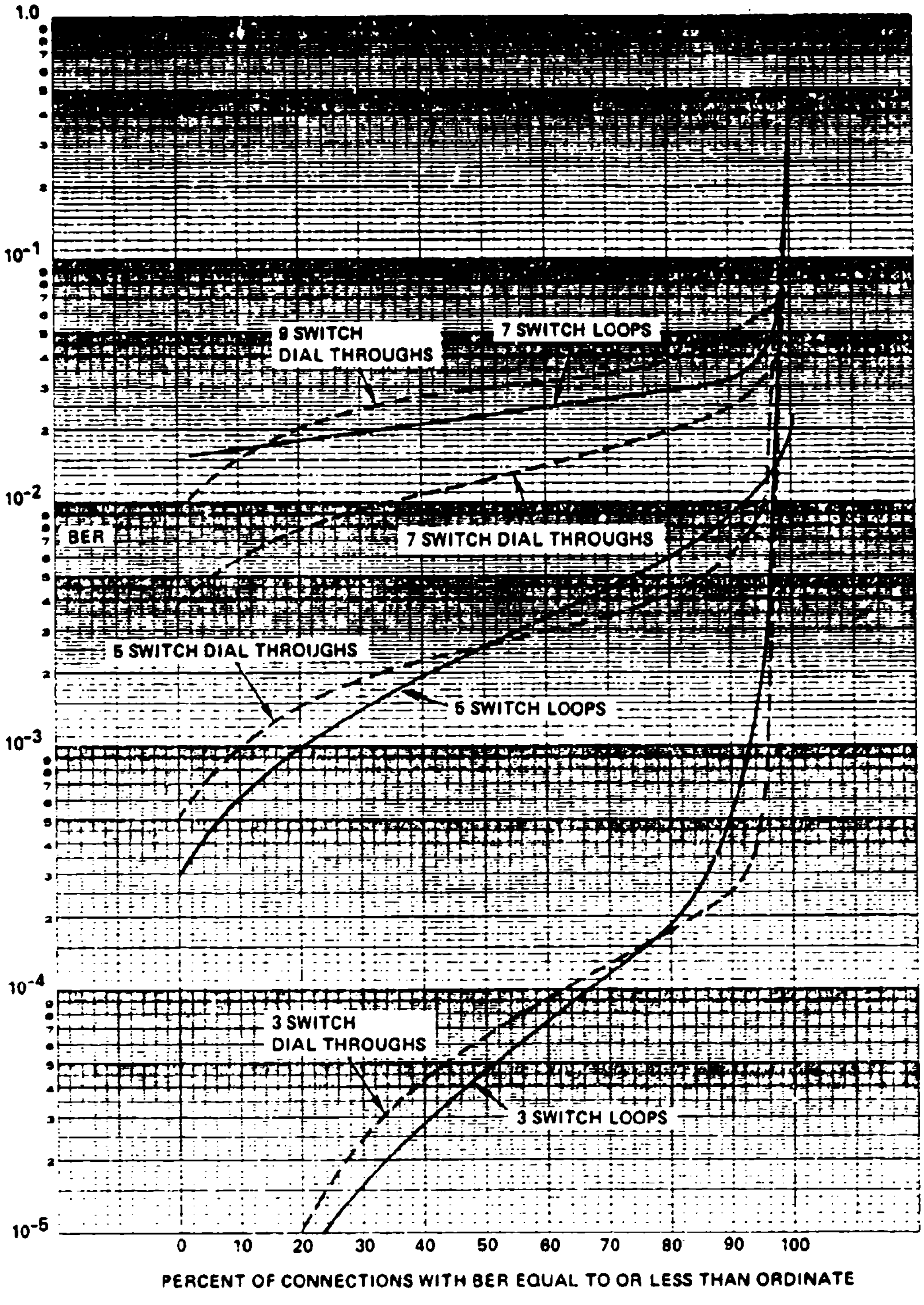


Figure 2.1.1-7. Comparison of Loop-Around and Dial-Through Calls in Non-Busy Hours

As can be seen, there appears to be almost no correlation between BER and distance to the switch involved. There is, however, a reasonabl variation from switch within a category which tends to argue that equipmen ariations at the point of baseband conversion is of more significance than the equipment in the long circuits that transmit the signal from switch to switch.

The next question of significance is the effect of busy hours on the data. The data presented, thus far, was gathered purposely in off-hours so that the probability of trunk blockage was minimized, hence, allowing a greater degree of certainty as to the number of switches involved in a call. During busy hours a call may be blocked on direct ISTs in its normal routing and seek alternate routes that require more switches. In addition, however, the effect of extra traffic might be expected to cause more crosstalk and switching noise, hence making the BER values worst even when extra switches are not involved.

A large number of calls (mostly looped calls)* were placed from Melbourne during busy hours. Analysis of this data shows strong evidence of the alternate routing effect but no visible evidence of worsened BER for cases where alt-routing is not likely. The basis of this observation is that the BER values for multiple busy-hour calls to a switch tend to be clustered into groups which logically might apply to calls involving differing number of switches in the call. To help assess this effect, an estimate of the probability of picking up extra switches on that call has been made. The basis of this estimate is given in Appendix A. The number of calls falling in each switch number category appear to correlate reasonably well with what might be expected based on the probabil[illegible]mates. The BER value within a switch number category appears, however, to be approximately the same as those measured during off hours.

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*In loop-around calls, the addition of one additional switch in reaching the destination inserts two switches in the transmission path since the return signal also transits the extra switch.

Figure 2.1.1-8 shows three cases where calls were made to the same switch during busy and non-busy hours. The two lower histograms involve looped calls to Julian, California, which involve a minimum of five switches. During busy hours, however, the probability of obtaining a five switch call was estimated to be 41 percent. The remaining probability is shown as corresponding to a seven or nine switch call. As can be seen, two of the ten calls are in the range of 0.3 to 0.4 percent, whereas the remaining calls are above 1 percent. It appears to be a reasonable interpretation that only two of the ten calls achieved the five switch configuration (although four might be expected) and the remaining calls involving seven or nine switches. Off-hour calls to Julian indicate that all of the ten BER values are in the same range as the two measured during busy hours. The next two histograms indicate performance on a loop to Frederiction, New Brunswick. In this case only a 1/3 probability exists to obtain a five switch call even during off hours since only one of the three most direct triple routing is capable of reaching Frederiction from Polk City with one intervening switch. As can be seen, three of the ten calls (which would be predicted) are definitely in a category by themselves. During busy hours the probability of a five switch call is reduced to 0.19 due to blockage. Two of the twenty calls are shown to fall in the same BER area as the non-busy hours traffic. The top two histograms apply to dial-through calls to San Luis Obispo, California. In this case 17 of the 20 busy-hour BER values in connections fall in the same range as the non-busy hour traffic. In this case, the number of higher switch calls might be expected to be four indicating that eight BER values would fall in the higher category. However, with a sample as small as ten calls, this type of variation might be expected.

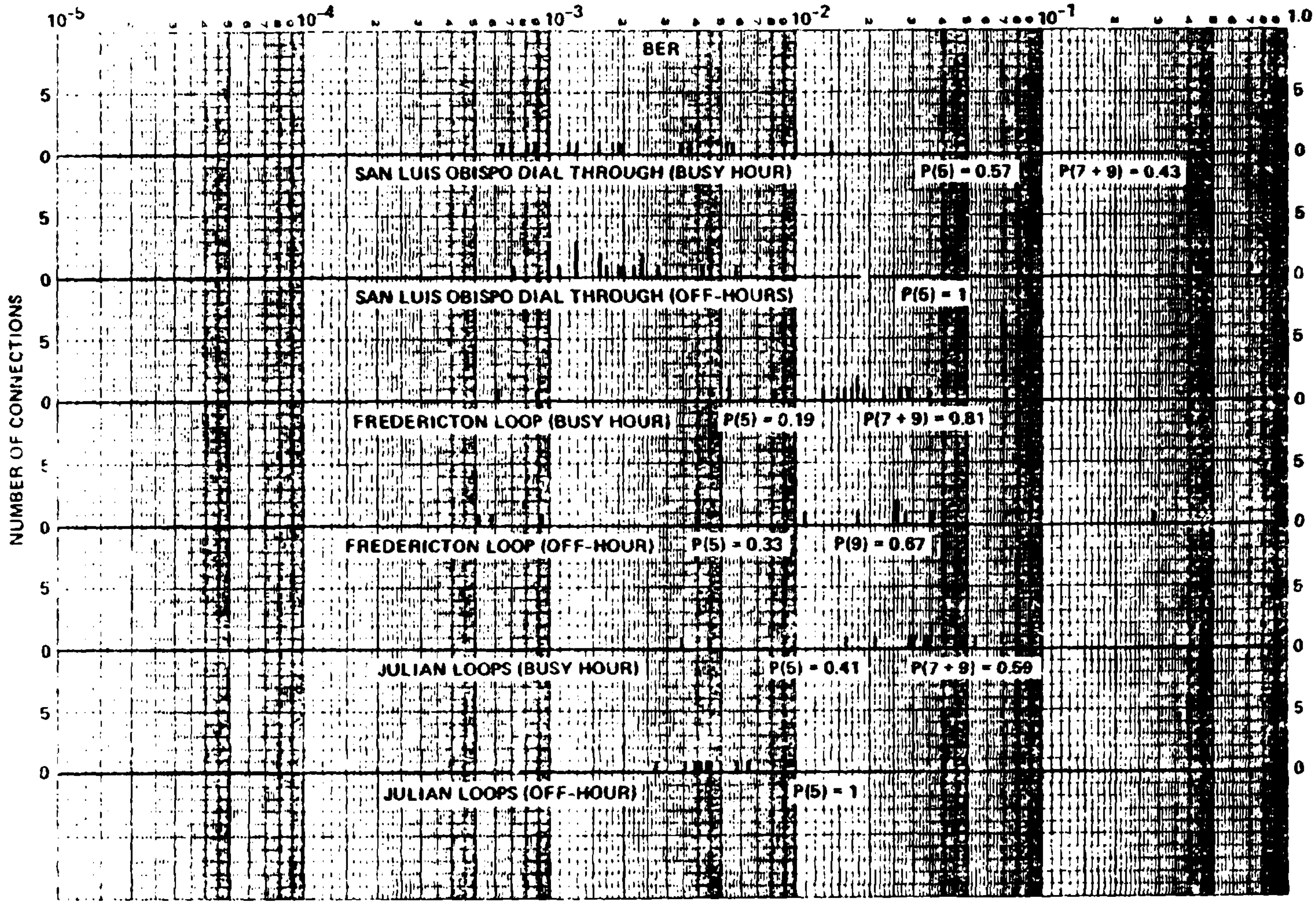


Figure 2.1.1-8. Busy-Hour Versus Off-Hour Performance (Histogram)

In Appendix A BER values obtained on 348 looped calls placed during busy hours are presented along with non-busy hour loops and dial-through calls. For each of the switches involved with the busy-hour calls, estimates have been made as to the probability of the number of switches involved in the call. Calls involving anomolous BER values have been indicated by asterisks. This data tens to support the conjecture that the principal effect of busy hour traffic upon BER values is due to rerouting rather than increased disturbance on a particular line. Although some increase must occur from extra traffic, it appears to be below the level of variation which occurs from call to call due to different equipment. This is probably due to the fact that the range of BER value of interest is quite high relative to that normally present in data transmission and occasional events such as switching noise do not occur frequently enough to significantly effect error rates of those magnitudes.

Figure 2.1.1-9 is a histogram of 328 looped calls placed during busy hours grouped in terms of the probability of the number of switches involved. Figure 2.1.1-10 shows the cumulative probability curve for these calls compared with those for looped calls during non-busy hours. As can be seen, the cumulative curves lie in the general region that might be anticipated for calls which have a mixture relative to the number of switches.

An important aspect of interpreting the modem test results, is to determine the distribution of the number of interswitch trunks (ISTs) that might be expected for normal and stress situations. To obtain these distributions the Defense Communications Engineering Center (DCEC) used their Network Performance Computer Analysis Model in conjunction with the Command Control and Technical Center (CCTC) provided Russian integrated single

Table 2.1.1-2. Distribution of IST Vs Number of Switches Destroyed

# OF IST	LOADING FACTOR (# OF TOTAL ERLANGS)									
	10	10	10	10	10	10	10	50	101	120
	NUMBER OF SWITCHES DESTROYED									
	0	1	6	8	16	27	30	10	27	30
1	0.67	0.67	0.62	0.67	0.63	0.59	0.59	0.59	0.53	0.50
2	0.29	0.29	0.33	0.29	0.32	0.28	0.29	0.34	0.28	0.30
3	0.03	0.03	0.05	0.03	0.05	0.09	0.09	0.07	0.13	0.13
4	---	---	---	---	---	0.01	0.02	---	0.03	0.05
5	---	---	---	---	---	---	---	---	0.01	0.01

*Total do not add to 1.00 due to rounding errors.

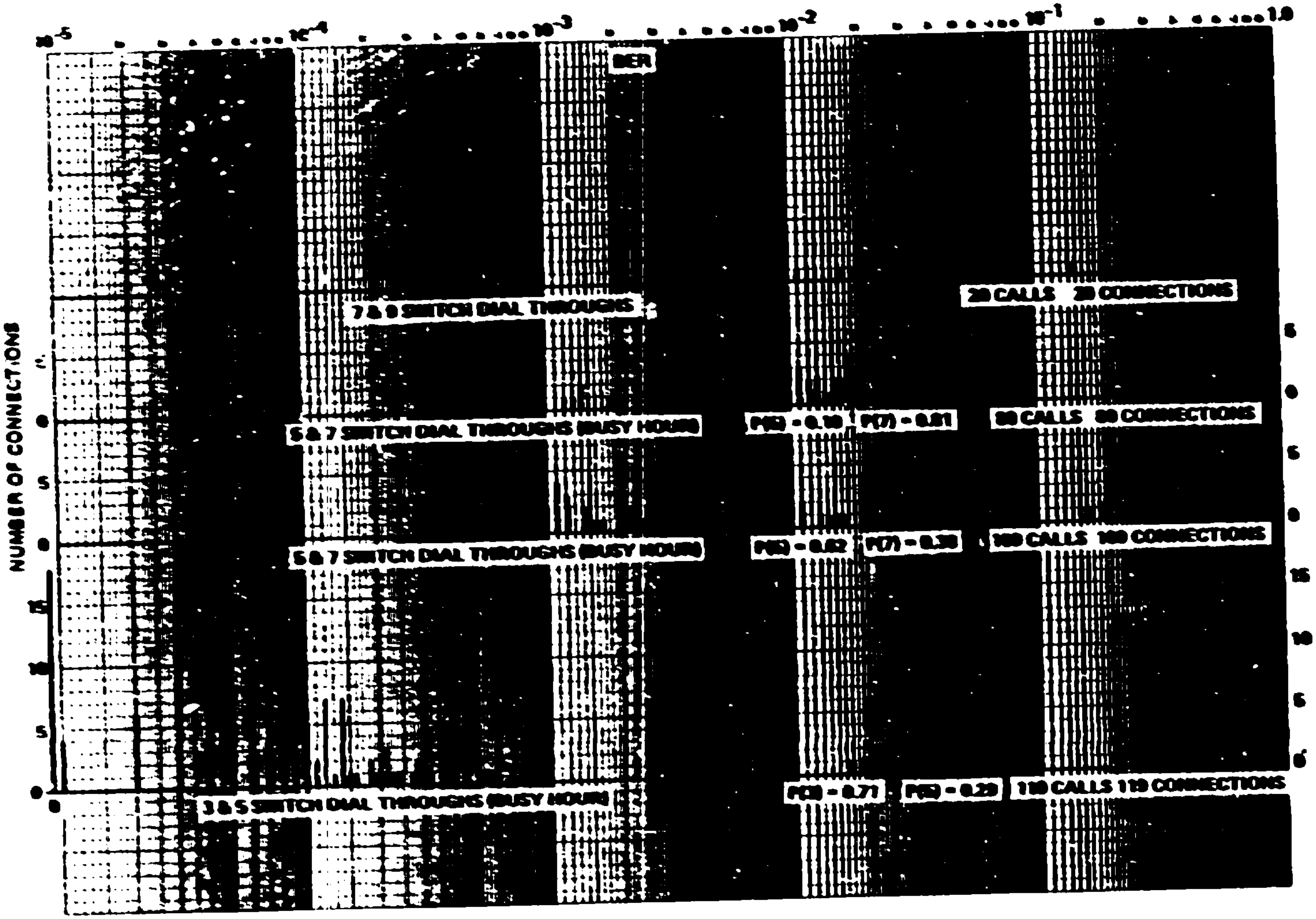


Figure 2.1.1-9. Histogram of Busy-Hour Loop-Around Calls From Melbourne

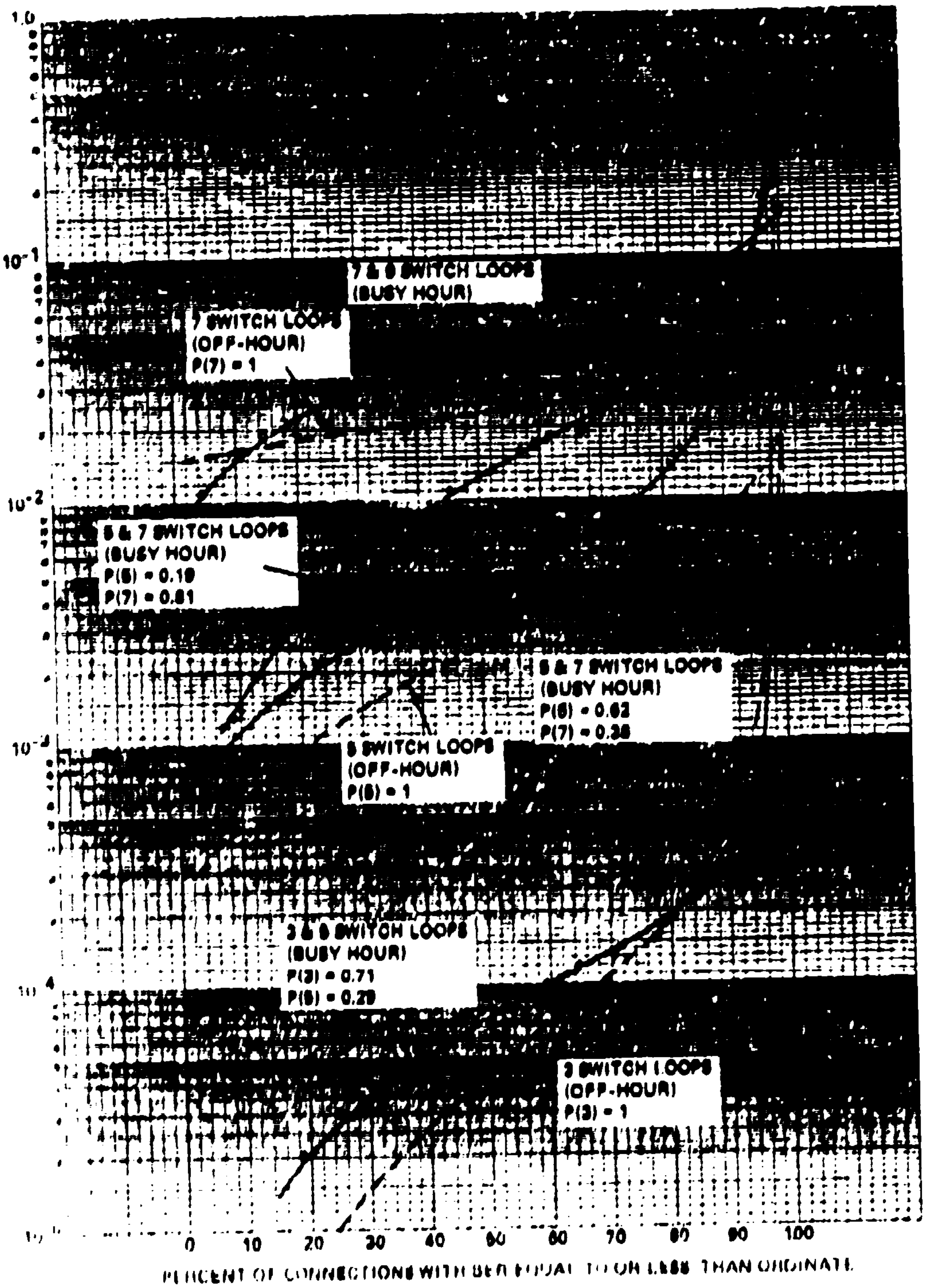


Figure 2.1.1 10. Busy-Hour Loop-Around Calls From Method of

operational plan (RIS OP) crisis senerio. The results are shown in Table 2.1.1-2 for 0 to 30 of the 59 CONUS swithes destroyed and using a 10 percent loading factor. The analysis was then repeated for increased loading factors and 10, 27 and 30 switches destroyed. There results show that except for a severely damaged network the mode will have to operate over at most three ISTs.

To summarize the Phase IV data, it appears that the principal network parameter that affects BER of the 16 kb/s modem is the number of switches involved in a call. When access lines are as good as those from Melbourne, a five switch call can be expected to be better than 1 percent on 92 percent of the connections. Since five switches are anticipated in only 6 percent of the calls even in worst case emergency condition; it can be concluded that good 16 kb/s operation is basically available on a switched network without modification of the ISTs presently available when a good access line is provided. It is interesting to note that the IST network has to be at least as good as it appears from the best access location. The question, however, is how the network appears from other access locations. In Paragraph 2.1.2 we will present the remaining four-wire data to attempt to answer this question.

Before proceeding to the Phase I and II data it is worthwhile to make one additional observation relative to the Phase IV data. The high degree of correlation that exists between 16 kb/s BER and the number of switches involved in a call tends to argue that the cause of the increased errors is due to a relatively common item associated with the first level MUXing operation and that this is inherent in the design rather than due to misadjustment since very few cases exist when the best of a five-switch call is as good as the worst of a three-switch call. Since many of the CONUS calls which have produced poor error rate have been diagnosed as having harmonic distortion levels, which are bothersome to the modem, it is a reasonable

conjecture that an amplifier associated with the MUXing operation produces a harmonic distortion level which is not in itself sufficient to adversely affect modem operation. However, when five, seven or nine of these are inserted in tandem the overall distortion is sufficient to adversely affect modem error rate. It should also be noted that SF units, which came under suspicion during the test program are unlikely to be the cause of this effect since a loop-around call should involve half the number of SF units as the dial-through calls with the same number of switches involved but the BER performance is approximately the same. This is not intended to argue that some of the anomolously bad calls are not caused by bad SF units but that the dominant error rate contributor is unlikely to be SF units.

2.1.2 Phase I and II Four-Wire Test Results

In this paragraph we will present the four-wire data gathered during Phases I and II and attempt to identify access line types which might provide unsatisfactory operation on the CONUS network when a five-switch call is present. Results from each of the site locations will be considered separately.

2.1.2.1 Four-Wire Data From the Pentagon

The Pentagon Autosevocom lines home on the Arlington switch and are connected through two or three miles of 22H88 or 22NL cable. There were four GP lines in service. No loop-around calls to the Arlington switch were performed on these lines. However, all indications are that such calls would have run either error free or at a very low error rate since normal calls to Melbourne from the Pentagon ran at a low error rate. A number of four-wire loop-around calls were placed from the ATT test facility during Phase I. The general purpose Autovon lines available at this facility are connected by cable also to Arlington and to Drainsville. Loop-around calls placed to locations other than the home switch ran into echo suppression problems and are not used in this section since their legitimacy is doubtful. Six loops on six different lines to the Drainsville switch were run without echo suppression problems. The BER was:

Line	BER
43100-127	0
43100-128	2.0E-5
43100-130	5.7E-4
43100-132	1.1E-3

Line	BER
43100-138	6.0E-5
43100-144	9.0E-5

Table 2.1.2.1 lists all of the long distance four-wire calls placed to or from the Pentagon in Phases I or II. All of these calls were made by the Autosevocom access lines through the Arlington switch. Along with the BER value given for each call is a statistical estimate as to the probability of that call having transitted the specified number of switches. This estimate was made from the IST blockage probability only and not from observation of the BER values. The BER values have been listed ommitting the E for exponent for simplification. Thus 6.2-5 means 6.2E-5.

Table 2.1.2.1. Four-Wire Calls From the Pentagon

Normal Calls

P(2) = 0.73	P(3) = 0.27	P(2) = 0.73	P(3) = 0.27	P(2) = 0.81	P(3) = 0.19	P(3) = 0.79	P(4) = 0.21
MED BER		MED BER	(Via Pol)	MED BER	(Via ELL)	MED BER	
Pent.	Melb.	Pent.	MacDill	Pent.	MacDill	Pent.	Offut
0	6.2-5	4.4-5	3.9-4	0	7.0-5	4.1-3	8.6-4
1.0-4	1.8-4	6.2-6	1.9-3	6.2-6	3.0-5	8.9-3	1.2-3
3.8-4	1.7-4	1.2-5	1.9-3	2.5-5	7.0-5	6.0-3	1.7-3
1.4-4	1.0-4	0	7.7-4	0	7.0-5	-	1.5-3
2.0-4	2.1-4	4.4-5	1.8-3			5.4-3	1.0-3
		1.0-4	1.7-3			5.9-3	7.6-3
		1.6-4	1.5-3			1.0-3	4.4-3
		1.1-4	1.1-3			4.9-3	5.3-4
		1.4-4	2.7-3				
		1.6-4	7.3-4				

Loops

3-5 Switch	BER	P(3)	P(5)	5-7 Switch	BER	P(5)	P(7)
ARL-WIL	2.1-3	0.95	0.05	ARL-CMC	9.4-3	1.0	0
ARL-POL	2.4-3	0.73	0.27	ARL-LYO	1.1-2	0.59	0.41
ARL-SLO	2.9-3	0.69	0.31	ARL-HEL	1.3-2	0.83	0.17
ARL-MOJ	8.9-3	0.32	0.68				
ARL-JUL	2.8-3	0.30	0.70				

Table 2.1.2.1. Four-Wire Calls From the Pentagon (Continued)

Dial Throughs

3-5 Switch DT	Pent. BER	Remote BER	P(3)	P(4)	P(5)
ARL-SEG-POL	7.7-4	6.1-3	0.72	0.26	0.02
LYO-NOR-ARL	7.6-4	4.3-3	0.49	0.41	0.10
LYO-NOR-ARL	2.8-3	2.9-3	0.49	0.41	0.10

4-7 Switch DT	Pent. BER	Remote BER	P(4)	P(5)	P(6)	P(7)
ARL-SEQ-JAS-POL	8.0-3	1.4-2	0.38	0.45	0.16	0.01
LYO-NOR-JAS-ARL	8.3-3	9.0-3	0.29	0.48	0.21	0.02
LYO-NOR-JAS-ARL	3.8-3	1.4-2	0.29	0.48	0.21	0.02

5-8 Switch DT	Pent. BER	Remote BER	P(5)	P(6)	P(7)	P(8)
LYO-NOR-MOS-POT-ARL	7.6-2	1.3-2	0.26	0.44	0.25	0.05
ARL-POT-MOS-NOR-LYO	-	2.1-2	0.26	0.44	0.25	0.05

6-9 Switch DT	Pent. BER	Remote BER	P(6)	P(7)	P(8)	P(9)
ARL-SEG-JAS-NOR-X-POL	6.2-2	4.4-2	0.23	0.42	0.25	0.10

Figure 2.1.2.1-1 shows a histogram of the normal calls involving the Pentagon. Figure 2.1.2.1-2 shows a histogram of the loop-around and dial-through calls involving the Pentagon. Since all calls were made during busy hours, the number of switches is not known and the distribution of BER values is more spread out than was the case of nonbusy hour calls from Melbourne. However, the tendency for higher BER values as the probability of a higher number of switches increases is present.

Figure 2.1.2.1-3 plots the cumulative probability of calls that are dominantly in the two switch, three switch and five switch category. To obtain these curves all categories of calls have been combined. As can be seen, the calls which are likely to be five switch calls run at a higher

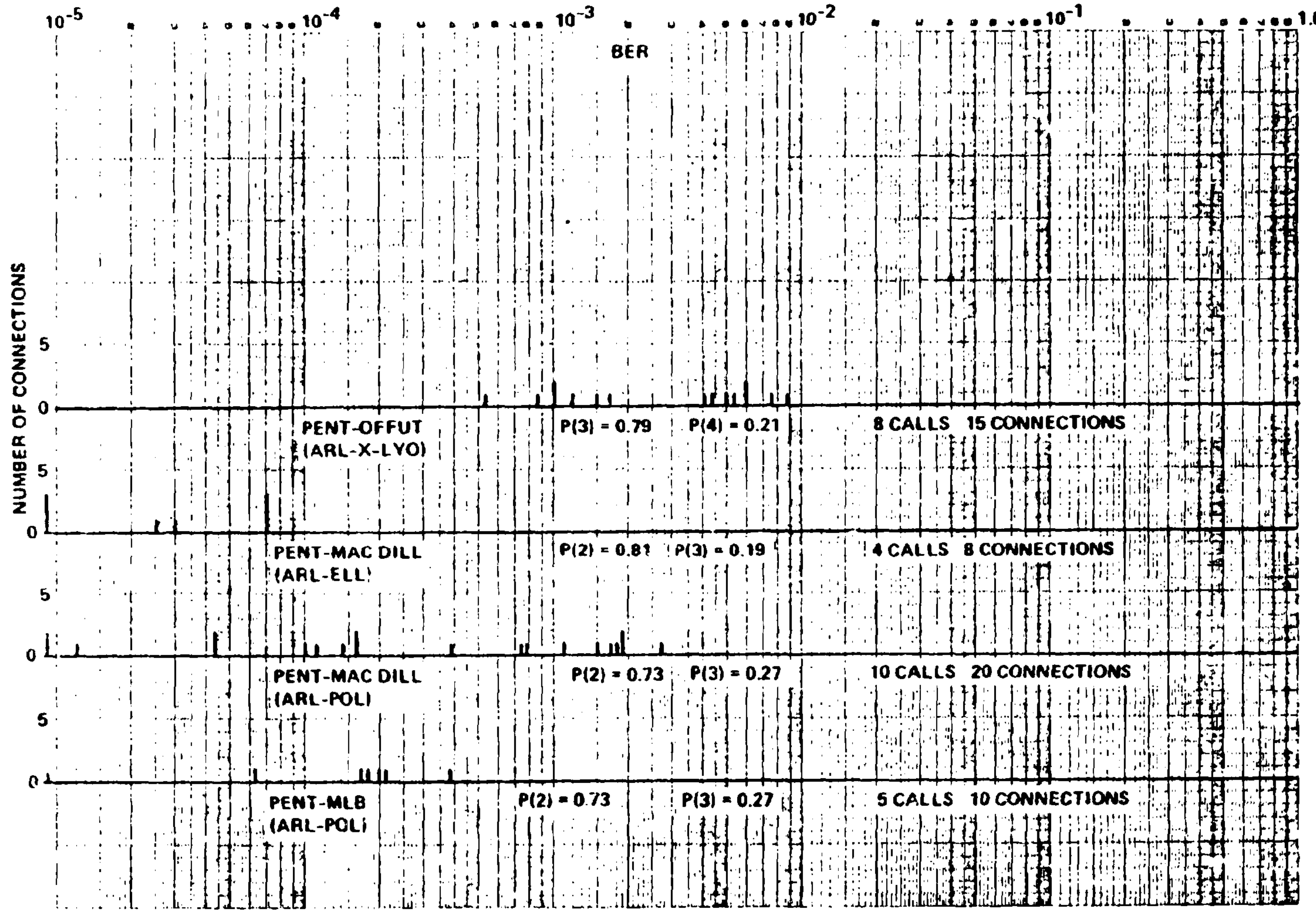


Figure 2.1.2.1-1. Four-Wire Normal Calls at Pentagon

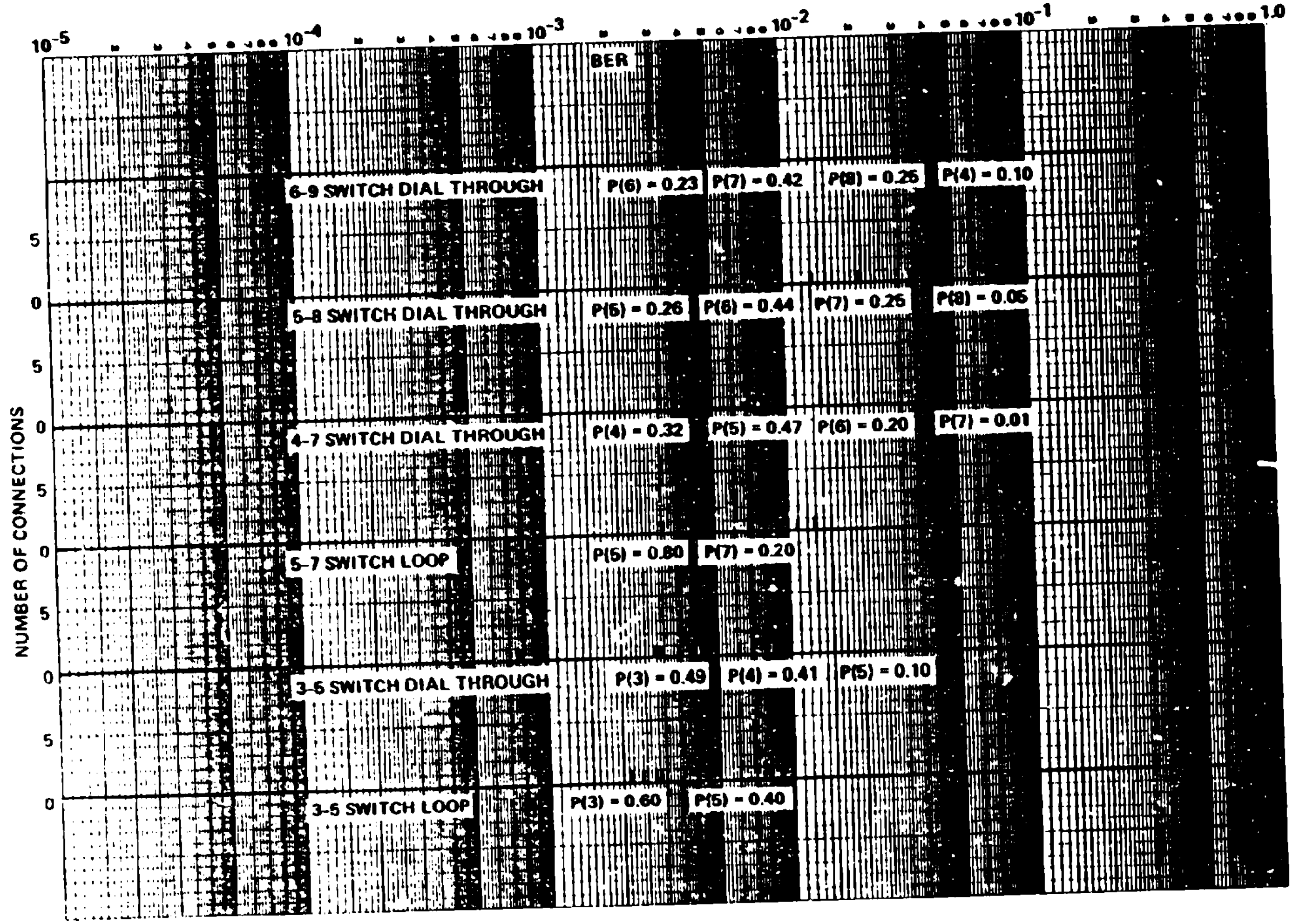


Figure 2.1.2.1-2. Four-Wire and Dial-Through at Pentagon

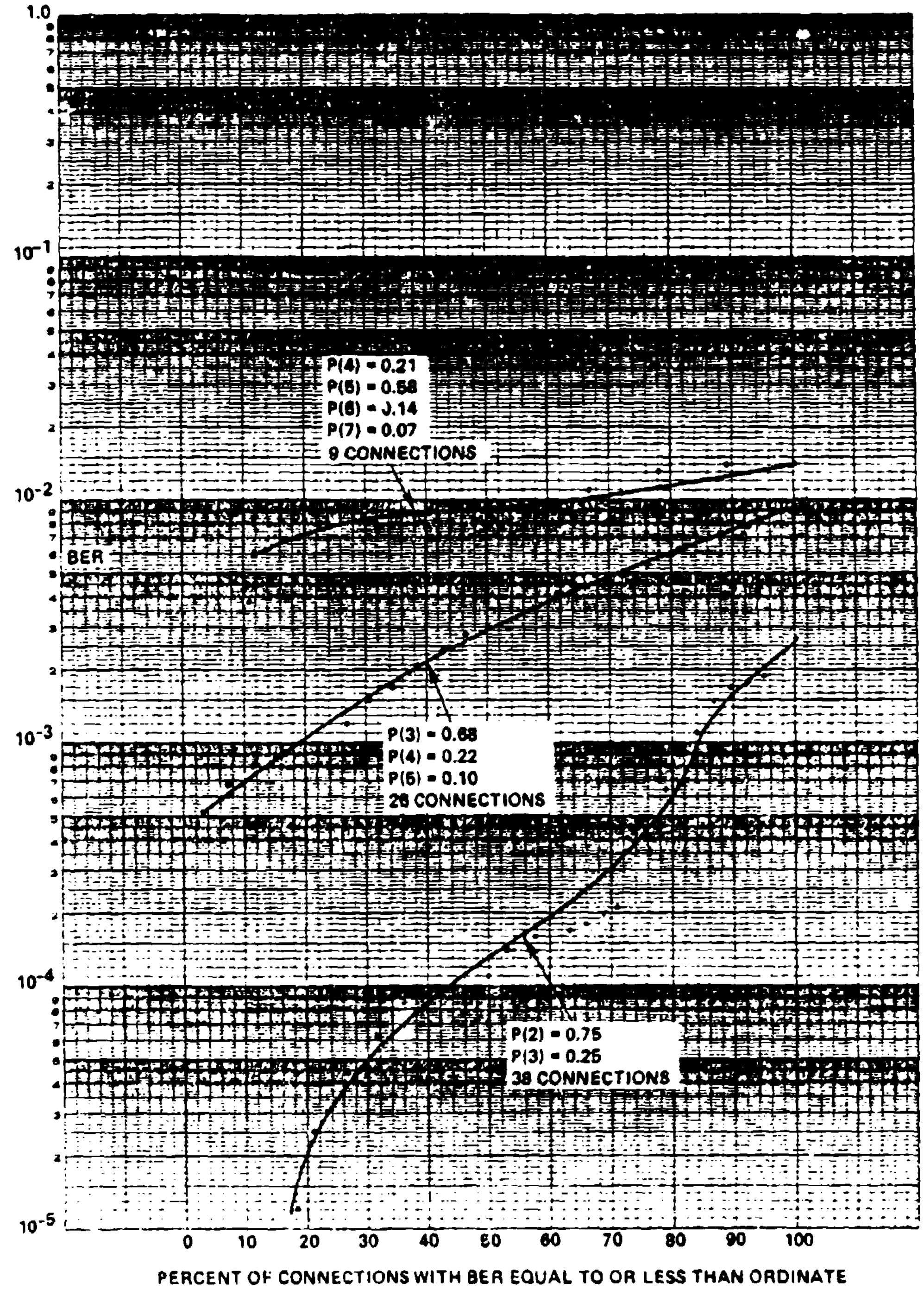


Figure 2.1.2.1-3. Calls Involving the Pentagon

error rate than those from Melbourne, but the worst of these is 1.4 percent. Thus, although the BER values from the Pentagon are worse than those from Melbourne, it appears likely that performance from the Pentagon would be acceptable even in an emergency. Figure 2.1.2.1-4 presents a comparison of Pentagon performance and Melbourne performance for non-busy dial-through calls.

2.1.2.2 Four-Wire Data From Offut AFB

There are five Autosevocom access lines from Offut AFB to the Lyons, Nevada switch. These use L1 carrier. During Phase I it was found that although the loop-around error rates to Lyons on these lines were good, the calls to Melbourne and long distance loops ran poorer than similar calls from general purpose Autovon lines from the Bell test facility at Offut. Tests were conducted by connecting the modem after the SF units on the Autosevocom line and considerable improvement existed. Specifically, a looped call to Polk City had a BER of 1.8 percent when the modem signal went through the SF unit. On the same call the BER was reduced to 0.35 percent when the modem was connected to the line side of the SF unit. Prior to tests in Phase II some of the older SF units were replaced. The EER value on local loops on the Autosevocom lines were:

Before SF Replacement		After SF Replacement	
Line Number	BER	Line Number	BER
1	0	1	0
2	0	2	0
3	0	3	6.7-4
4	0	4	1.0-5
5	5.0-5	5	5.0-5

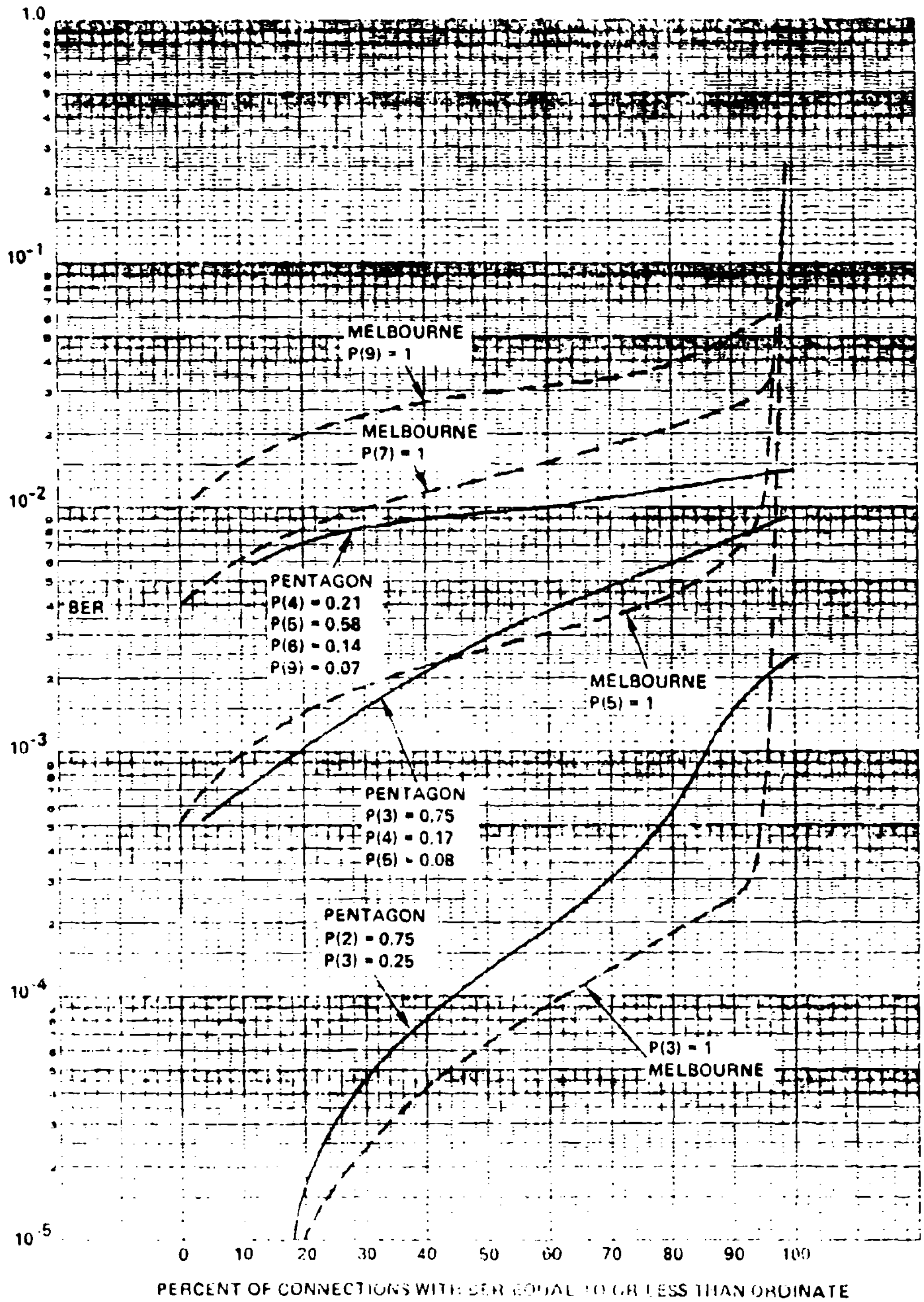


Figure 2.1.2.1-4. Comparison of Four-Wire Calls From Pentagon and Melbourne

Although this does not indicate improvement, some improvement was noticed on long distance calls. Figure 2.1.2.2-1 is a histogram of Offut calls prior to replacement of the SF unit. Figure 2.1.2.2-2 is a histogram of calls either placed after the SF exchang or from a location not involving the SF units. Table 2.1.2.2 lists the calls from Offut with data not involving the bad SF units indicated by an asterisk. Figure 2.1.2.2-3 shows the cumulative BER values for the calls after the SF unit was replaced. Figure 2.1.2.2-4 compares these results with those obtained from Melbourne. As can be seen, the performance on five-switch calls is similar to that at the Pentagon. The performance is generally worse than that observed at Melbourne, but should provide usable error rates even when five switches are involved.

2.1.2.3 Four-Wire Calls From Cheyenne Mt

The calls from Cheyenne Mt were a combination of calls from a four-wire administrative phone in technical control of the Cheyenne Mt complex and calls from the Cheyenne Mt Autovon switch. These calls used IST circuits to four adjacent switches; Fairview, Lamar, Mounds and Socorra as access lines. The four-wire phone was connected to the Cheyenne Mt switch by a short cable. The IST circuits were L1 carrier facilities. Access loop results were:

Access Line	BER
Four-Wire Phone to CMC Switch	4.0-5
Lamar IST	0
Mounds IST	0

The four-wire data from Cheyenne Mt is listed in Table 2.1.2.3. Figure 2.1.2.3-1 is a histogram of normal calls from CMC. Figure 2.1.2.3-2 is a

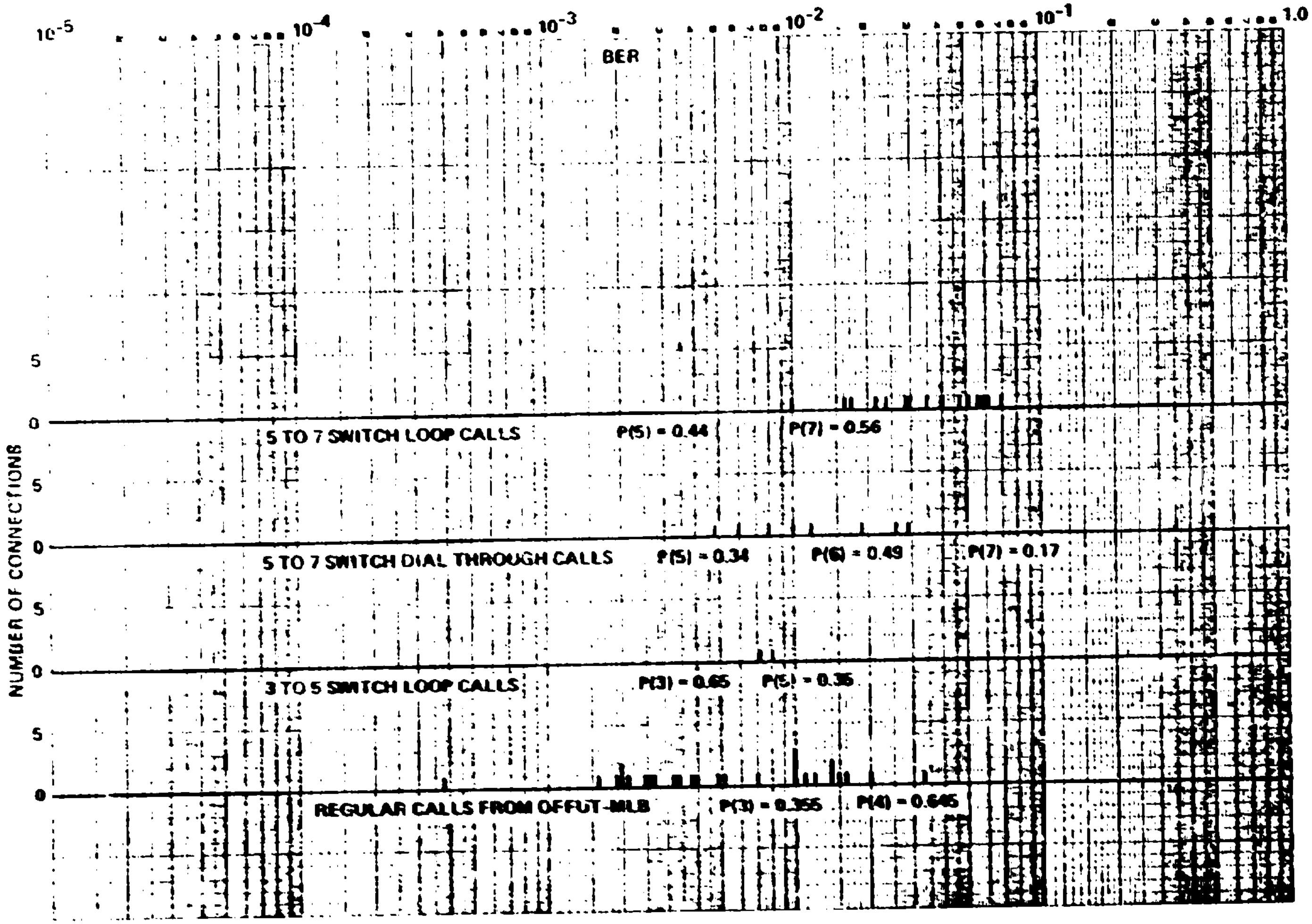


Figure 2.1.2.2-1. Calls at Offut Before SF Modifications

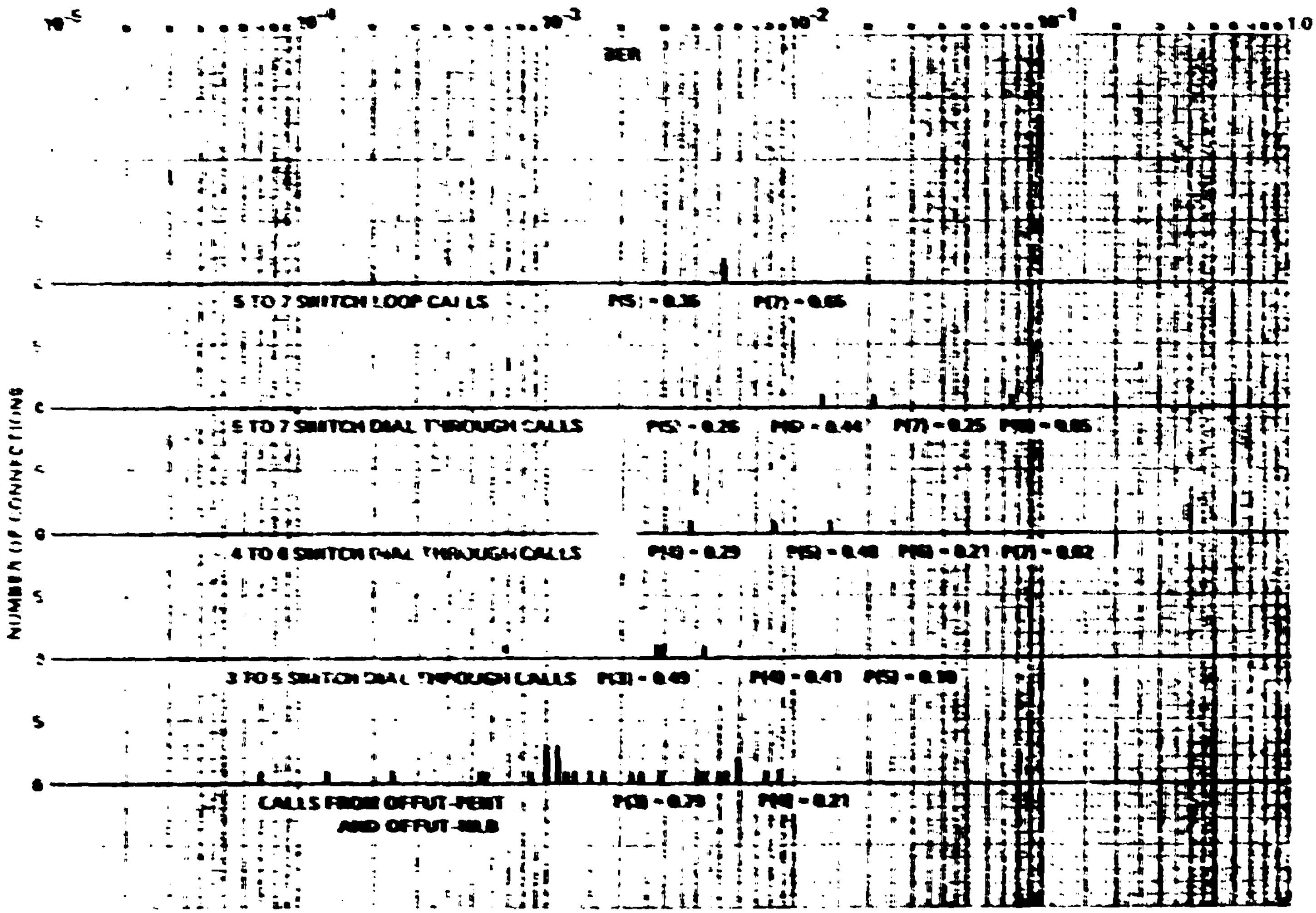


Figure 2.1.2.2-2. Calls at Offut After SF Modifications

Table 2.1.2.2. Four-Wire Calls from Offut

Normal Calls

P(3) = 0.35	P(4) = 0.65	P(3) = 0.79	P(4) = 0.21	P(3) = 0.35	P(4) = 0.65
MED BER (SVC Calls)		*MED BER (SVC Calls)		*MED BER (AV Calls)	
Offut	Melb.	Offut	Pent.	Offut	Melb.
5.1-3	1.6-3	8.6-4	4.1-3	2.8-3	2.2-3
9.8-3	4.0-3	1.2-3	8.9-3	1.1-3	2.4-3
1.1-3	2.7-3	1.7-3	6.0-3	1.1-3	2.4-4
1.4-2	2.1-3	1.5-3	-	1.3-3	1.1-3
7.1-3	3.4-3	1.0-3	5.4-3	1.3-4	1.0-3
3.3-2	2.0-3	7.6-3	5.9-3	5.6-4	7.0-5
2.0-2	2.6-3	4.4-3	1.0-3		
1.0-2	3.8-3	5.3-4	4.9-3		
1.6-2	3.3-3				
1.4-2	2.5-3				
1.2-2	2.0-3				
4.8-3	3.8-4				
1.0-2	1.9-3				
1.5-2	-				

Loops

3-5 Switch	BER	P(3)	P(5)
LYO-HEL	7.3-3	0.69	0.31
LYO-JUL	8.1-3	0.60	0.40

5-7 Switch	BER	P(5)	P(7)
LYO-MOS	2.4-2	0.76	0.24
LYO-SLO	2.2-2	0.50	0.50
LYO-CMC	9.9-3	1.0	0
LYO-MOJ	1.7-2	0.52	0.48
LYO-HAG	5.3-2	0.26	0.74
LYO-POL	3.0-2	0.35	0.65
LYO-POL	6.0-2	0.35	0.65
LYO-POL	5.5-2	0.35	0.65
LYO-POL	2.9-2	0.35	0.65
LYO-POL	4.0-2	0.35	0.65
LYO-POL	6.1-2	0.35	0.65
LYO-POL	5.8-2	0.35	0.65
LYO-POL	7.0-2	0.35	0.65
LYO-POL	4.8-2	0.35	0.65
LYO-POL	3.5-2	0.35	0.65
LYO-POL	1.8-2	0.35	0.65
*LYO-POL	5.2-3	0.35	0.65
*LYO-POL	5.2-3	0.35	0.65

Table 2.1.2.2. Four-Wire From Offut (Continued)

3-5 Switch DT	Offut BER	Remote BER	Dial Throughs P(3)	P(4)	P(5)
*LYO-NOR-ARL	6.7-4	4.3-3	0.49	0.41	0.10
*LYO-NOR-ARL	2.8-3	2.9-3	0.49	0.41	0.10

4-7 Switch DT	Offut BER	Remote BER	P(4)	P(5)	P(6)	P(7)
*LYO-NOR-JAS-ARL	9.3-3	8.3-3	0.29	0.48	0.21	0.02
*LYO-NOR-JAS-ARL	1.4-2	3.8-3	0.29	0.48	0.21	0.02

5-8 Switch DT	Offut BER	Remote BER	P(5)	P(6)	P(7)	P(8)
*LYO-NOR-MOS-POT-ARL	1.3-2	7.6-2	0.26	0.44	0.25	0.05
*ARL-POT-MOS-NOR-LYO	2.1-2	-	0.26	0.44	0.25	0.05
LYO-X-MOS-X-LYO	1.9-2	5.9-3	0.44	0.46	0.10	0
LYO-X-SLO-X-LYO	9.9-3	2.9-2	0.26	0.50	0.24	0
LYO-X-SLO-X-POL	7.9-3	4.8-3	0.33	0.50	0.17	0
LYO-X-SLO-X-POL	2.6-2	1.2-2	0.33	0.50	0.17	0

*Calls not involving bad SF units.

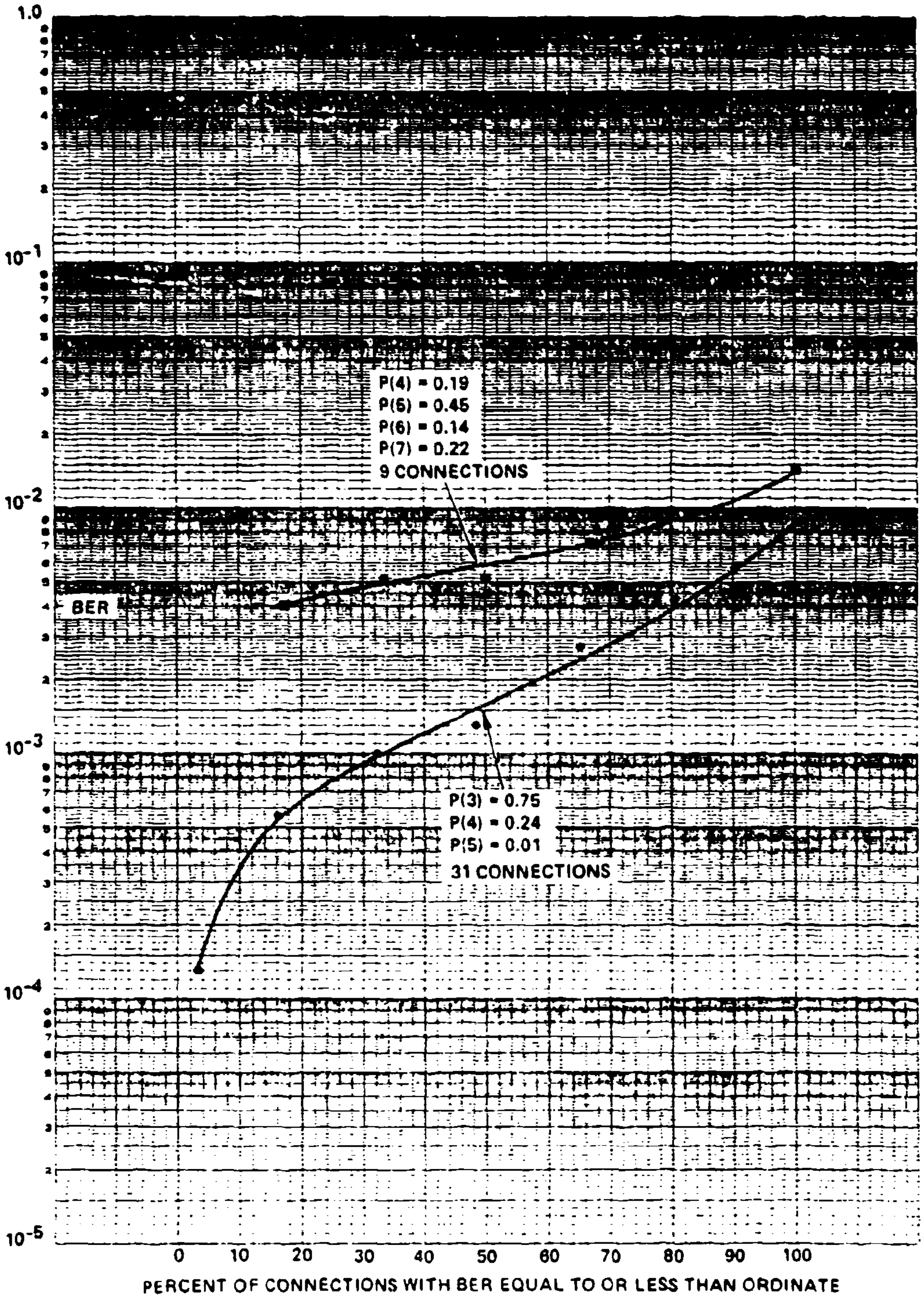


Figure 2.1.2.2-3. Calls From Offut After SF Modifications or Not Involving SF

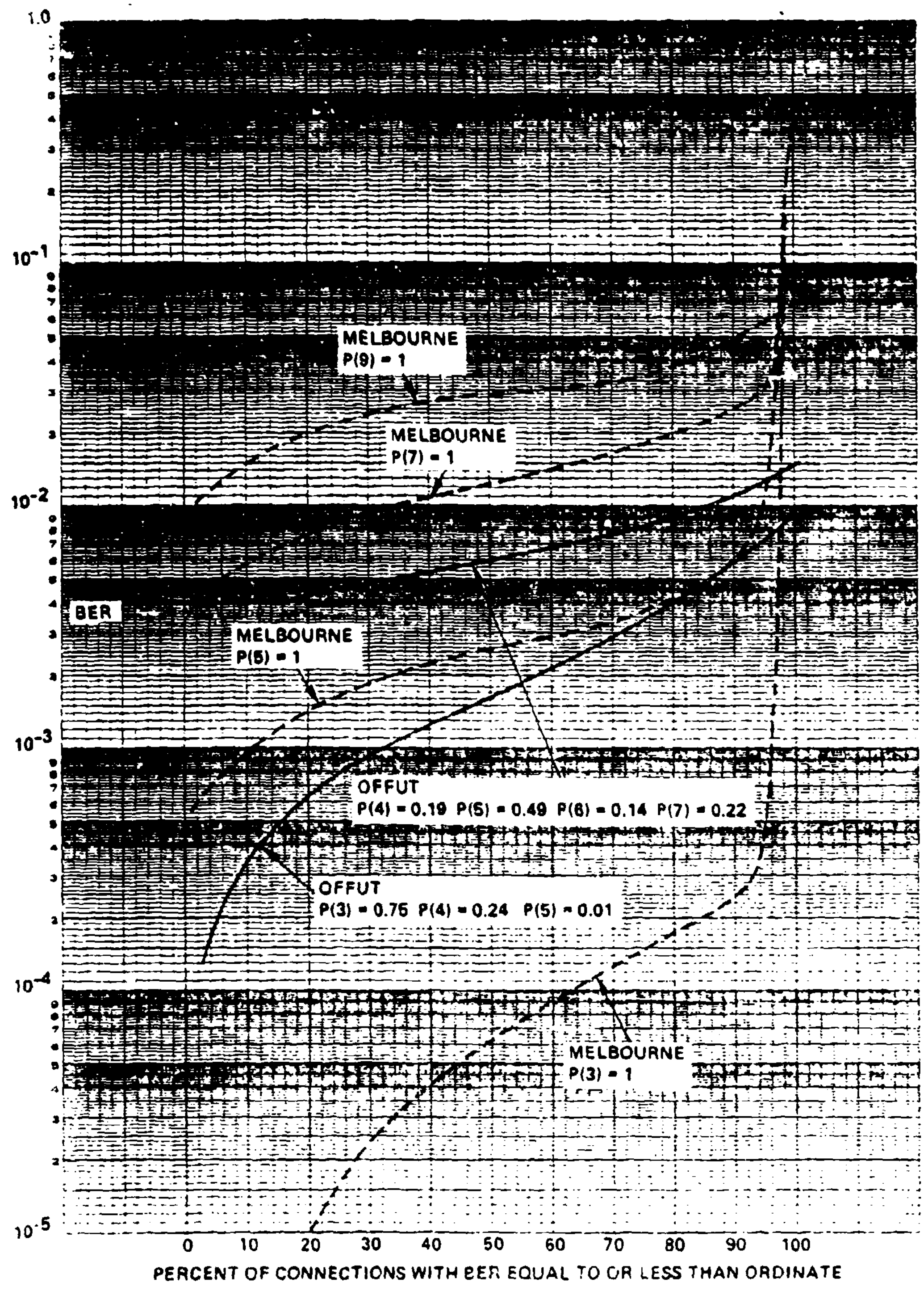


Figure 3.1.2.2-4. Comparison of Four-Wire Calls From Offut and Melbourne

Table 2.1.2.3. Four-Wire Calls From Cheyenne Mt Complex

Normal Calls

P(3) = 0.17 MED BER CMC	P(4) = 0.83 (Via CMC) Melb	P(3) = 0.60 MED BER CMC	P(4) = 0.40 (Via LAM) Melb	P(3) = 0.78 MED BER CMC	P(4) = 0.22 (Via FVW) Melb	P(3) = 0.55 MED BER CMC	P(4) = 0.45 (Via MOU) Melb	P(3) = 0.50 MED BER CMC	P(4) = 0.50 (Via SOC) Melb
8.0-3	1.5-3	2.8-4	2.0-3	1.6-3	2.3-3	3.5-4	7.9-4	2.0-4	6.6-4
3.2-3	1.9-3	7.7-4	1.9-4	7.0-5	2.4-4	8.8-4	2.5-3	2.4-4	2.7-4
3.7-3	1.5-3	1.2-3	2.8-4						
7.8-4	1.2-3	9.1-4	2.5-4						
7.8-4	1.7-3	9.1-4	1.4-4						
1.8-3	1.6-3								
3.6-3	4.4-3								
7.9-3	-								
3.5-3	3.1-3								
2.9-3	3.8-3								

Loops

3-5 Switch	BER	P(3)	P(5)	5-7 Switch	BER	P(5)	P(7)	7-9 Switch	BER
CMC-HEL	1.8-3	0.99	0.01	CMC-MOS	1.4-2	0.55	0.45	CMC-HAG	4.3-2
CMC-LAM	7.0-4	1.0	0	CMC-MOJ	2.3-3	0.42	0.58	CAC-FRE	3.0-2
CMC-LAM	2.6-4	1.0	0	CMC-JUL	6.0-3	0.54	0.46	LAM-FRE	2.9-2
CMC-MOU	2.9-3	0.99	0.01	CMC-YAK	4.2-3	0.48	0.52	SOC-FRE	2.2-2
LAM-MOU	1.2-4	0.74	0.26	LAM-POL	1.6-3	0.60	0.40		
FVW-LAM	1.2-4	0.63	0.37	LAM-MEM	4.8-3	0.53	0.47		
SOC-POL	3.1-4	0.50	0.50	LAM-BRE	7.8-3	0.62	0.38		
SOC-YAK	1.4-3	0.65	0.35	MOU-POL	8.8-3	0.77	0.23		
				MOU-FRE	9.4-3	0.36	0.64		
				FVW-POL	9.2-4	0.78	0.22		
				FVW-FRE	4.9-3	0.73	0.27		
				CMC-POL	6.5-3	0.17	0.83		
				CMC-POL	1.4-2	0.17	0.83		
				CMC-POL	1.4-2	0.17	0.83		

Dial Throughs

5-7 Switch DT	CMC BER	Remote BER	P(5)	P(6)	P(7)
CMC-X-SLO-X-POL	1.4-3	8.6-3	0.27	0.53	0.20
CMC-X-ARL-X-POL	2.3-3	2.7-3	0.51	0.41	0.08
CMC-X-YAK-X-POL	8.4-2	1.7-2	0.48	0.52	0
CMC-X-YAK-X-POL	1.7-2	1.9-2	0.48	0.52	0

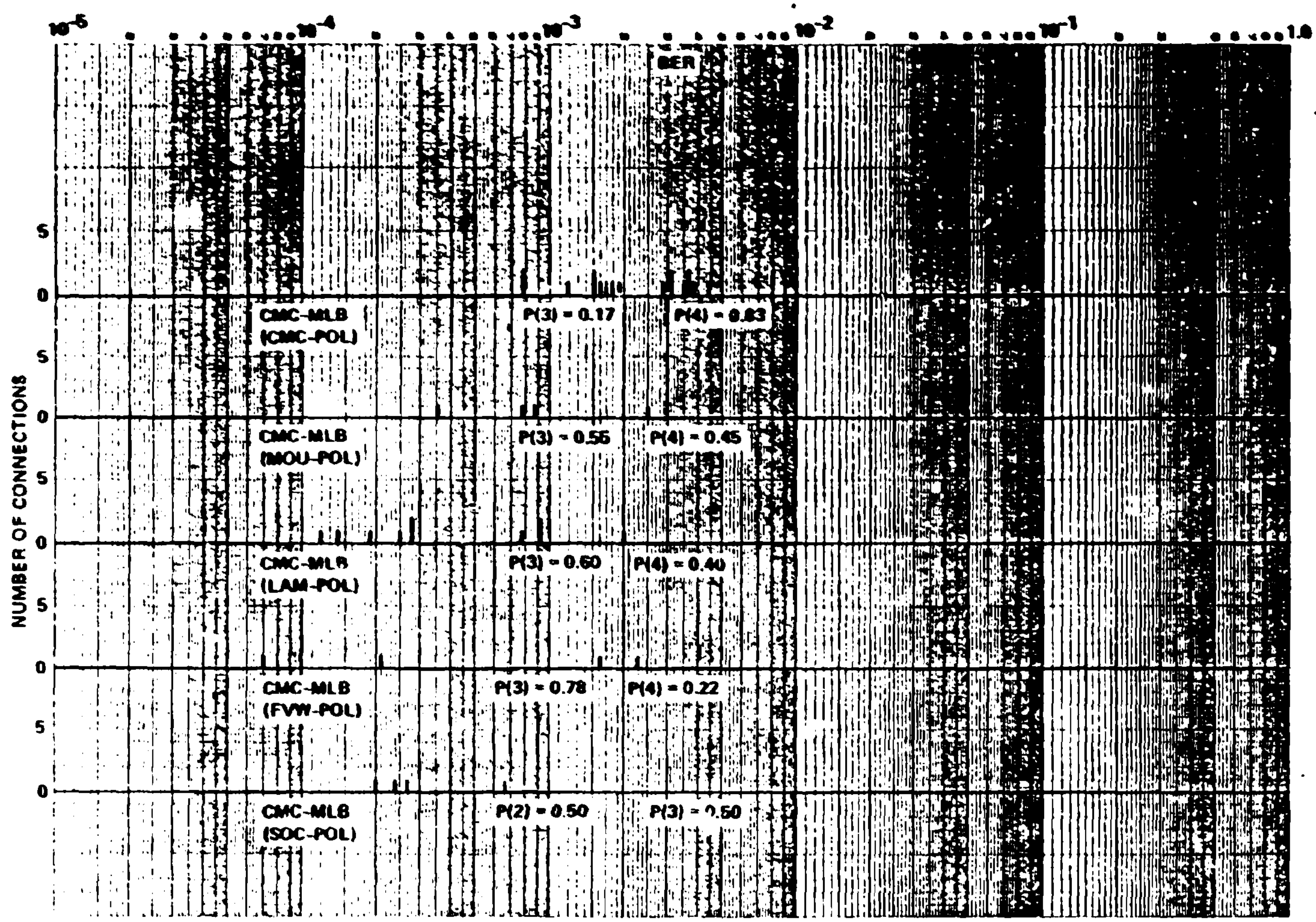


Figure 2.1.2.3-1. Four-Wire Regular Calls at Cheyenne Mt Complex

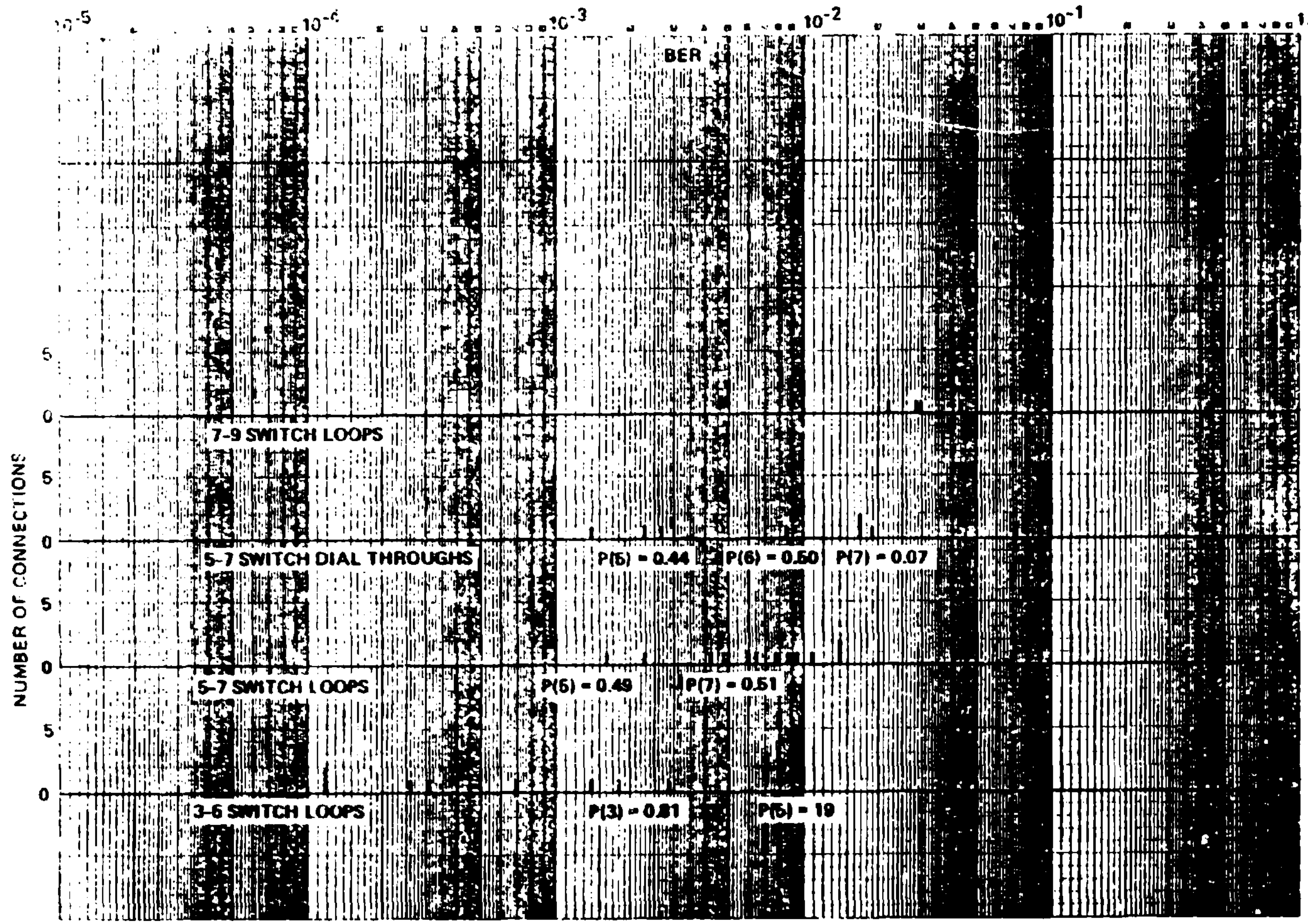


Figure 2.1.2.3-2. Four-Wire Loops at Cheyenne Mt Complex

histogram of looped calls from CMC. Figure 2.1.2.3-3 is the cumulative probability of calls in the 3-5 switch category and the 5-7 switch category. Figure 2.1.2.3-4 compares these results with those from Melbourne. As can be seen, the results from CMC are similar to those from Melbourne.

2.1.2.4 Four-Wire Calls From McChord AFB

The Autovon calls from McChord AFB in Washington, were all placed on general purpose Autovon lines which home on the North Bend switch through cable and radio (L1). In addition to the Autovon lines several DCS non-Autovon lines were tested to obtain samples of other types of carrier systems. The results were:

Loop To	Carrier Type	BER	Dist (One Way)
North Bend	L1	0	54.6 miles (GP Autovon)
Mt. Livingston	ON2	8.4-4	155.3
Billingham	ON2	1.4-2	151.6
Seattle	BN	3.2-2	63.4
Tacoma	N1	3.1-2	32.3
Seattle	N1	6.7-3	63.4

As can be seen, performance on most of the N carrier systems was quite poor for a local loop.

Table 2.1.2.4 lists the four-wire calls from McChord. Figure 2.1.2.4-1 is a histogram of this data. Figure 2.1.2.4-2 shows the cumulative distribution of this data and Figure 2.1.2.4-3 compares these results with Melbourne results. As was the case at Cheyenne Mt these results compare favorably with those obtained at Melbourne.

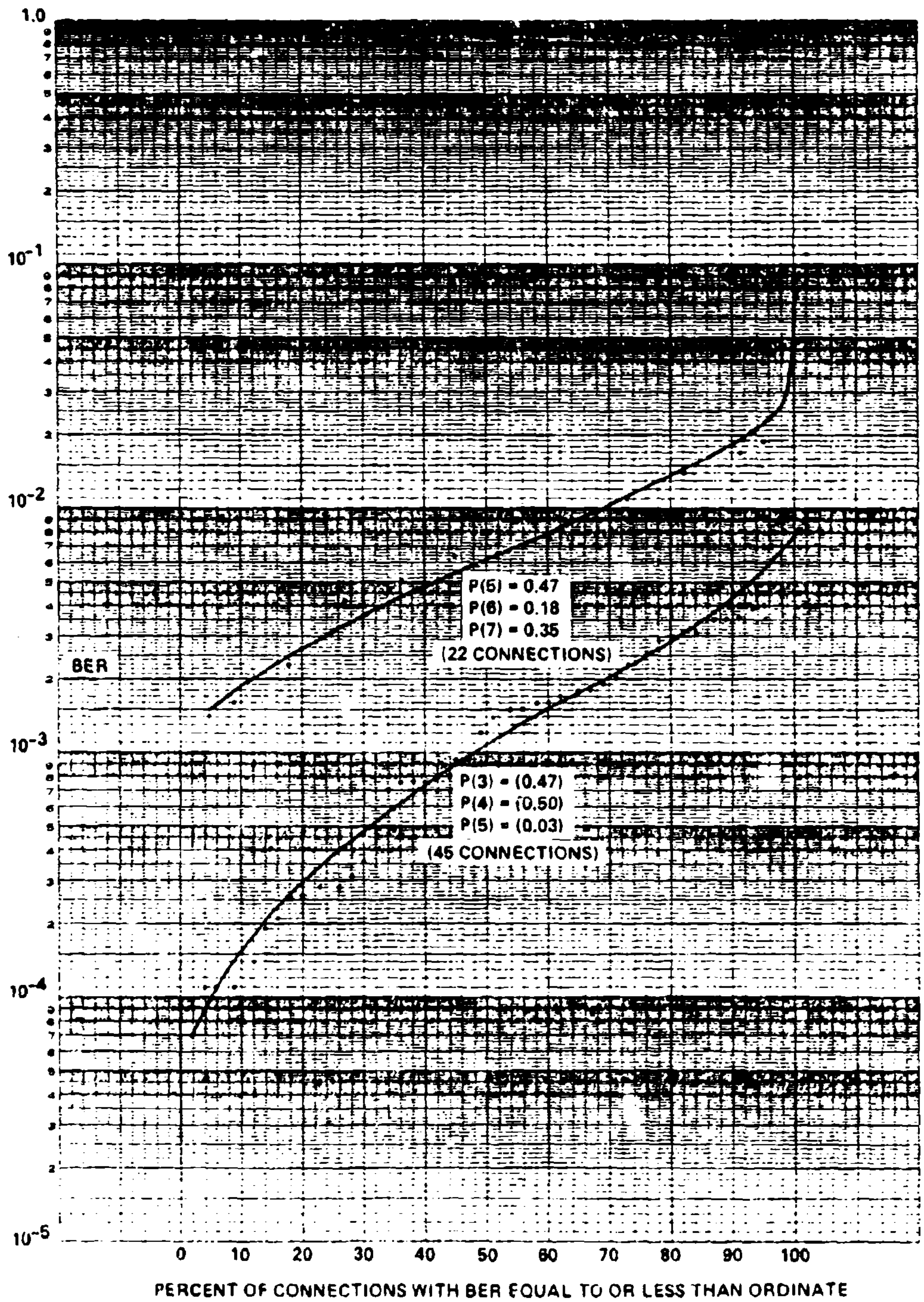


Figure 2.1.2.3-3. Calls Involving Cheyenne Mt

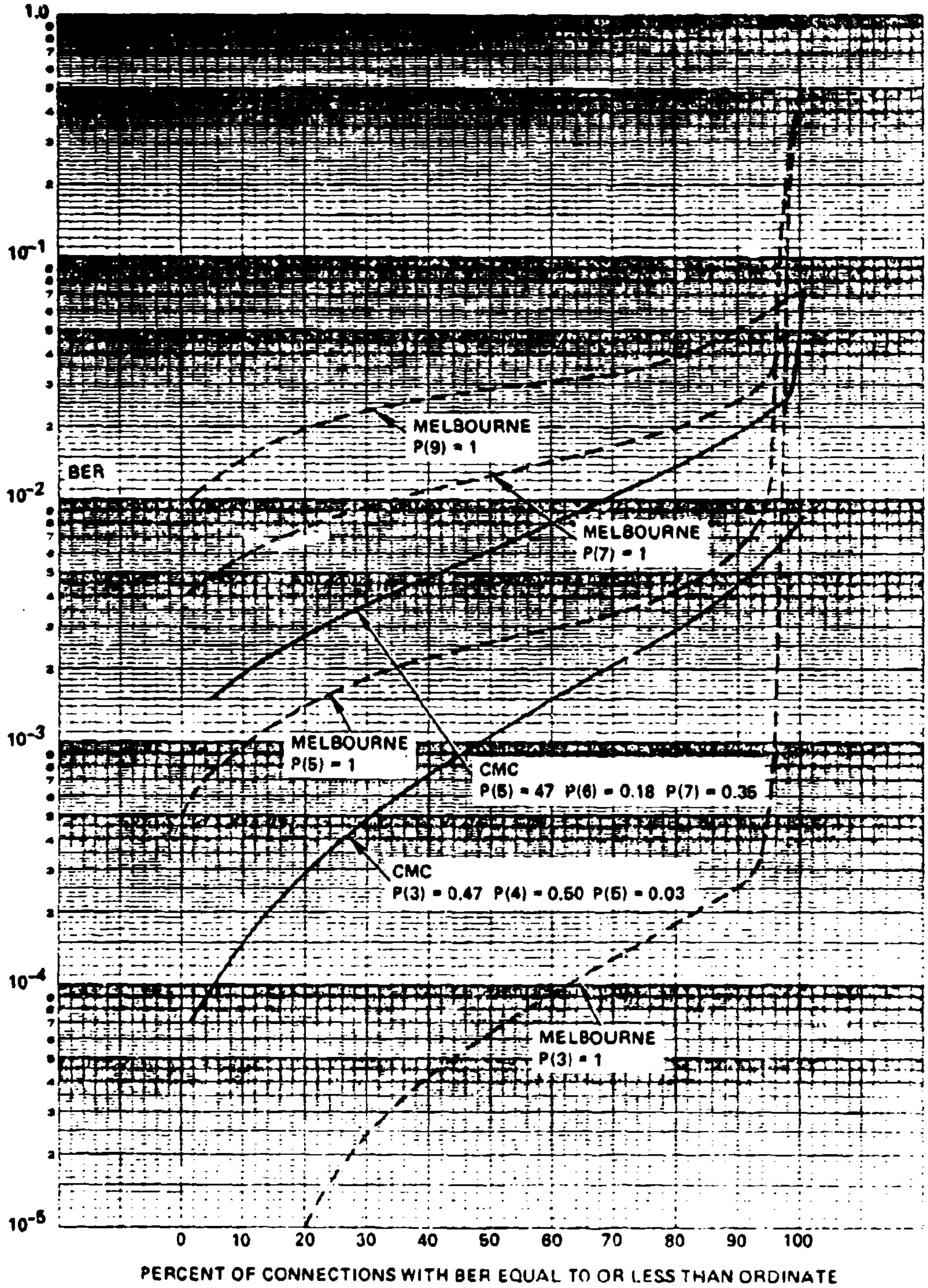


Figure 2.1.2.3-4. Comp[illegible] From CMC and Melbourne

Table 2.1.2.4. Four Wire Calls From McChord

Normal Calls

P(3) = 0.16 P(4) = 0.84

MED BER

McChord	Melb
8.8-4	1.2-4
1.0-3	4.2-3
4.5-3	2.5-4
3.5-4	2.1-3
2.0-3	5.0-4
1.7-4	2.2-2
1.4-3	4.2-3

Loops

3-5 Switch	BER	P(3)	P(5)
MBD-ARL	7.0-4	0.64	0.36
NBD-YAK	0	0.97	0.03
NBD-HEL	4.5-4	0.84	0.16

5-7 Switch	BER	P(5)	P(7)
NBD-POL	1.9-3	0.16	0.84
NBD-LYO	1.0-2	0.61	0.39
NBD-CMC	3.2 3	1.0	0
NBD-LAM	7.8-3	0.25	0.75
NBD-MOU	2.7-3	0.48	0.52
NBD-MEM	5.6-3	0.14	0.86
NBD-JAS	5.3-3	0.69	0.31
NBD-BRE	2.4-2	0.70	0.30
NBD-BRE	1.7-2	0.70	0.30
NBD-FRE	2.3-2	0.74	0.26
NBD-FRE	3.7-3	0.74	0.26

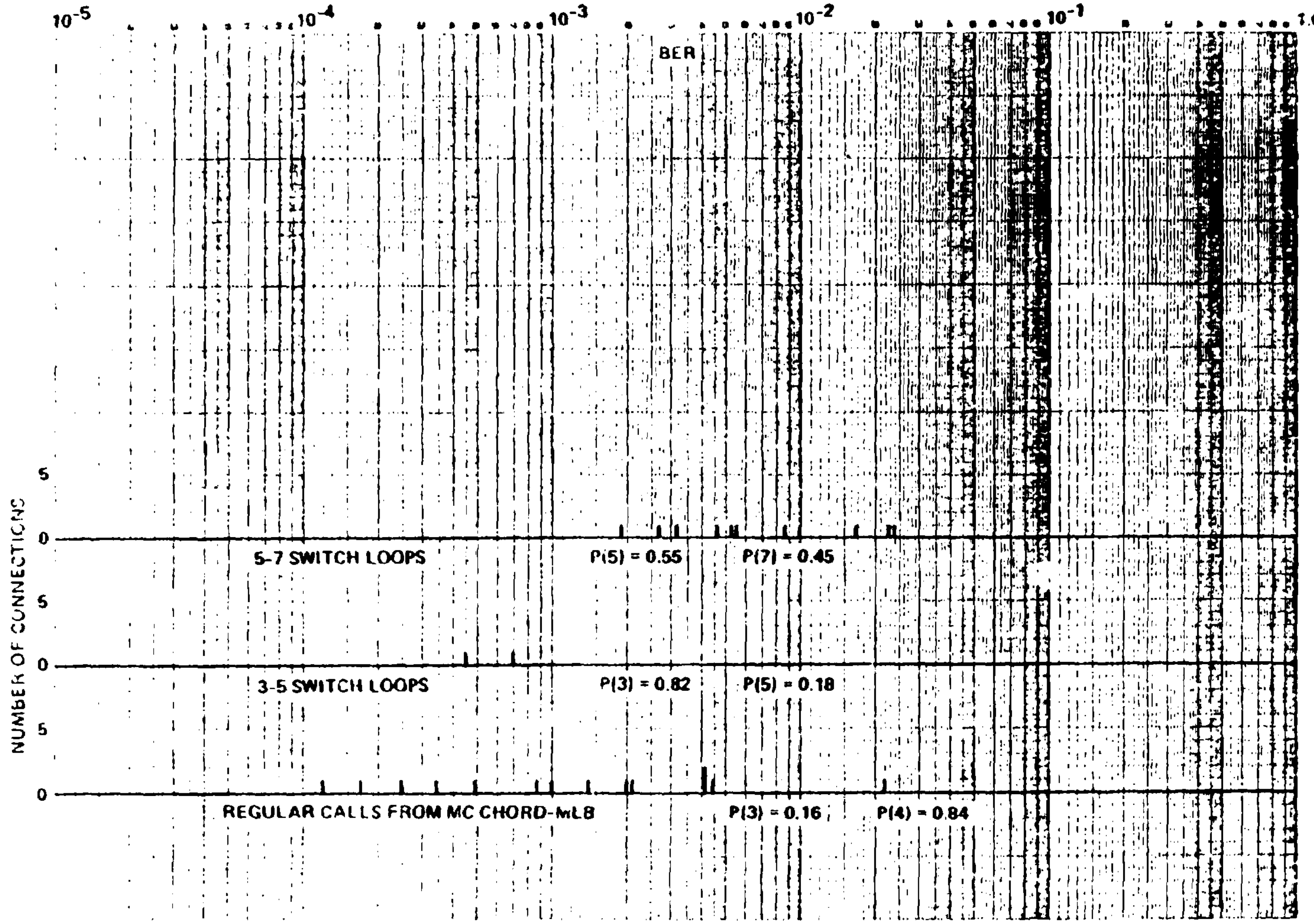


Figure 3.1...4-1. Four-Wire Calls From McChord

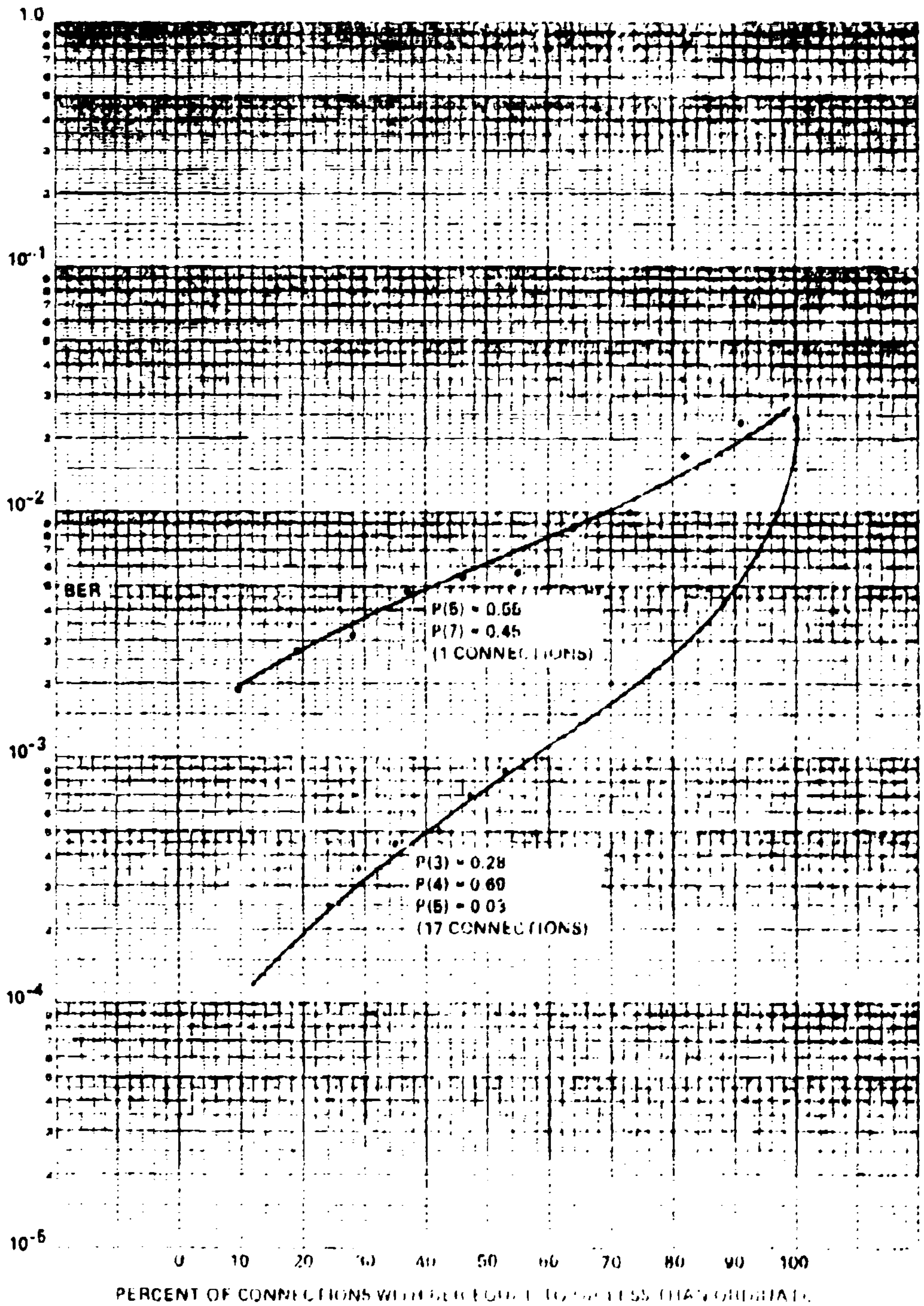
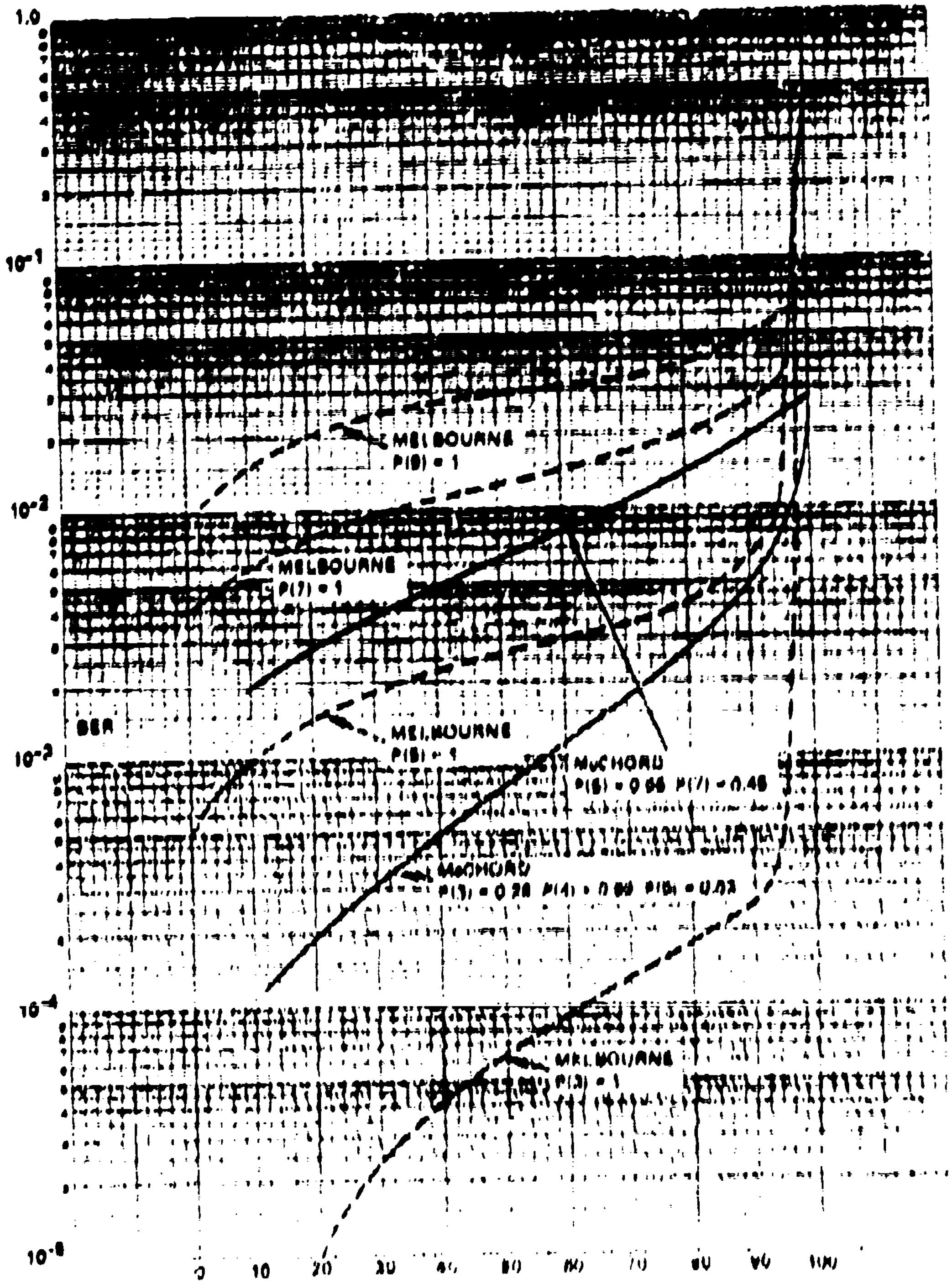

BER
P(6) = 0.55
P(7) = 0.45
(1 CONNECTIONS)
P(3) = 0.28
P(4) = 0.69
P(5) = 0.03
(17 CONNECTIONS)
1.0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0 10 20 30 40 50 60 70 80 90 100
PERCENT OF CONNECTIONS WITH BER EQUAL TO OR LESS THAN ORDINATE

Figure 2.1.2.4 [illegible]


1.0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
BER
MELBOURNE
P(8) = 1
MELBOURNE
P(7) = 1
MELBOURNE
P(5) = 1
McCHORD
P(6) = 0.96 P(7) = 0.46
McCHORD
MELBOURNE
P(3) = 1
0
10
20
30
100

Figure

63

2.1.2.5 Four-Wire Calls from Vandenberg AFB

The calls from Vandenberg were all placed on general purpose Autovon lines, which homed on the San Luis Obispo switch. These lines used ON and N2 carrier systems to reach San Luis Obispo. Local loop results were:

Loop to	Carrier Type	BER
SLO	ON	9.1-3 AV
SLO	N2	8.5-3 AV
Santa Maria	T1-D3	0 (Circuit not yet operational)

As can be seen, looped BER on these N carrier lines were relatively poor.

Table 2.1.2.5 lists the four-wire data from Vandenberg. All of the calls involved either ON or N2 carrier systems. Figure 2.1.2.5-1 is a histogram of these calls. Figure 2.1.2.5-2 presents the cumulative results and Figure 2.1.2.5-3 compares these results with Melbourne results. As can be seen, the results are relatively poor even for calls which are dominantly three switch calls. Although usable operation might be achieved over these lines for normal routing, satisfactory operation with five-switch calls appears doubtful.

2.1.2.6 Four-Wire Calls From March AFB

All of the four-wire calls from March AFB were placed during Phase I on general purpose access lines to the Julian switch and the Mojavi switch. These access lines are a mixture of N2 and cable and radio links. Three access loop tests were all on TMX lines. These results were:

Loop to	Type of Carrier	BER
MOJ	TMX	9.0-6
MOJ	TMX	2.6-4
JUL	TMX	3.0-5

Table 2.1.2.5. Four-Wire Calls From Vandenberg

Normal Calls

P(3) = .66 P(4) = .34

MED BER

Vand	MELB
1.2-3	8.5-3
2.1-3	1.1-2
5.1-3	2.2-2
3.2-3	5.4-3
6.2-3	7.2-3
4.8-3	8.5-3

Loops

3-5 Switch	BER	P(3)	P(5)	5-7 Switch	BER	P(5)	P(7)
SLO-MOJ	4.5-2	.39	.61	SLO-MEM	5.8-2	.45	.55
SLO-SWE	1.6-2	.39	.61	SLO-POL	3.9-2	.64	.34
SLO-ARL	6.4-2	.42	.58	SLO-FRE	7.3-2	.14	.86
SLO-MOJ	1.1-2	.39	.61	SLO-MEM	2.8-2	.45	.55
SLO-SWE	1.5-2	.39	.61	SLO-POL	1.9-2	.66	.34
SLO-ARL	2.2-2	.42	.58	SLO-FRE	3.9-2	.14	.86
SLO-NRD	6.5-2	.45	.55	SLO-LYO	3.4-2	.51	.49
SLO-JUI	1.3-2	.42	.58	SLO-YAK	3.3-2	.58	.42

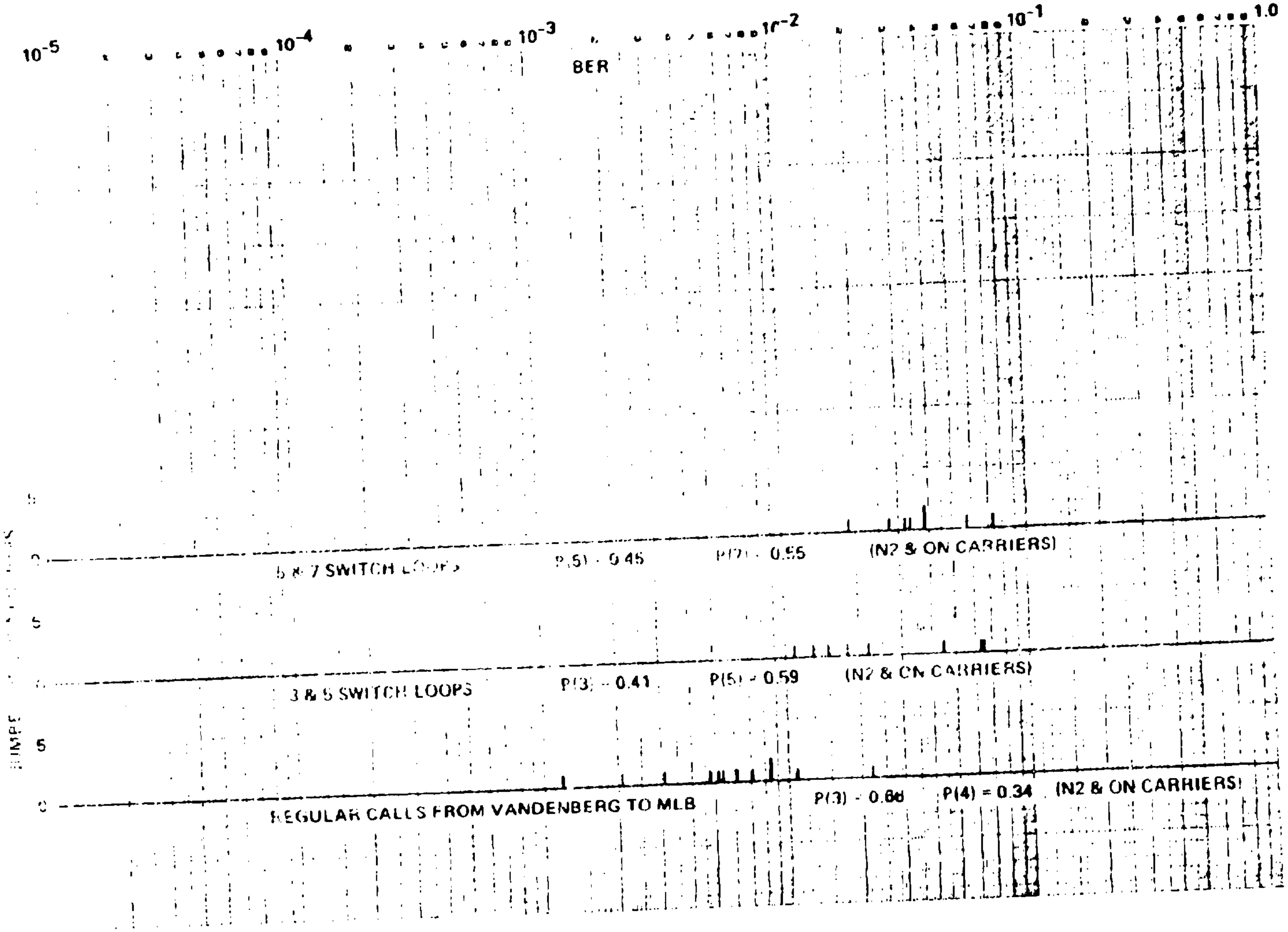


Figure 2.1.2.5-1. Four-Wire Calls From Vandenberg

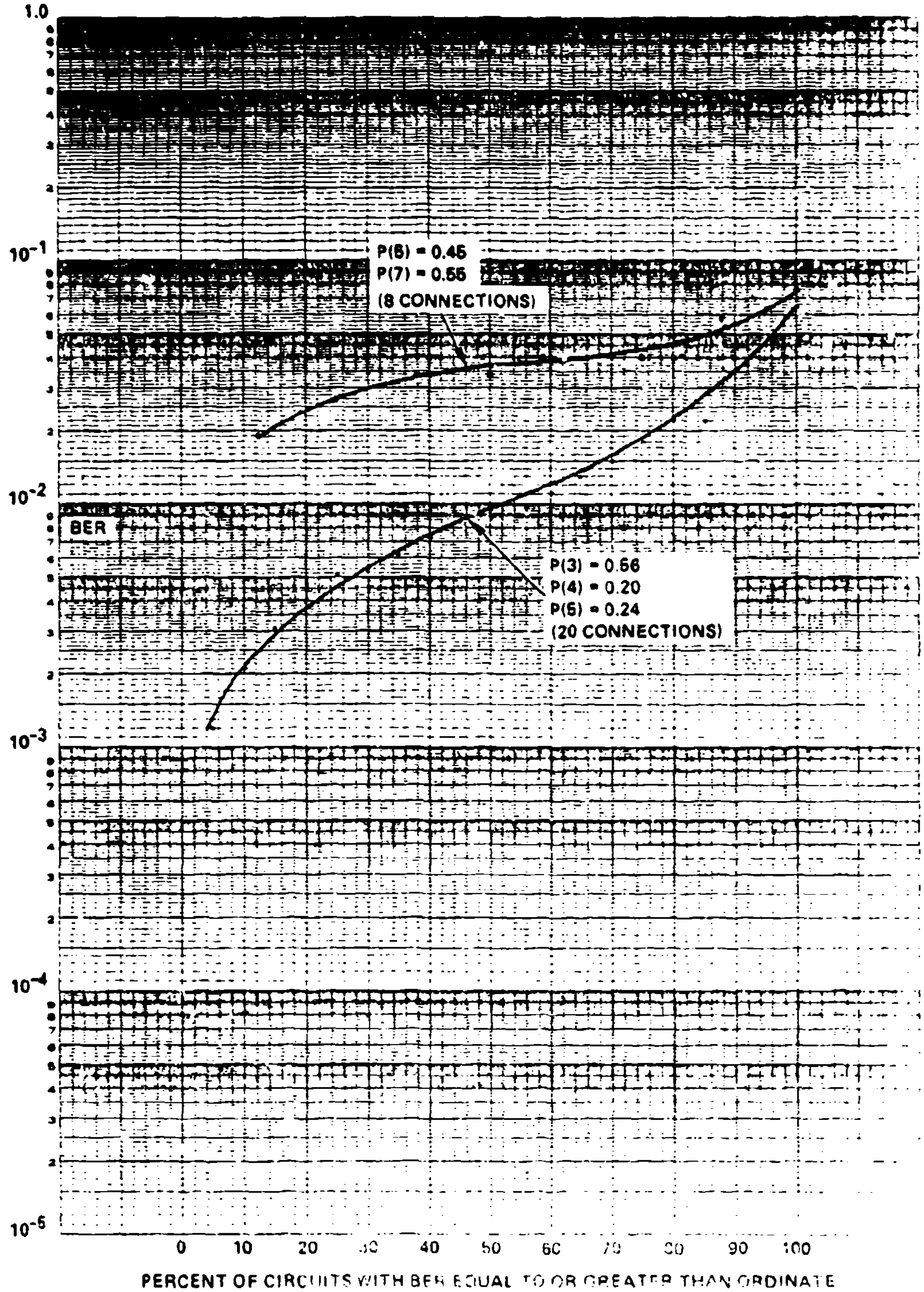

1.0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
BER
P(6) = 0.45
P(7) = 0.55
(8 CONNECTIONS)
P(3) = 0.56
P(4) = 0.20
P(5) = 0.24
(20 CONNECTIONS)
0
10
20
40
50
60
90
100
PERCENT OF CIRCUITS WITH BER

Figure 2.1.[illegible]

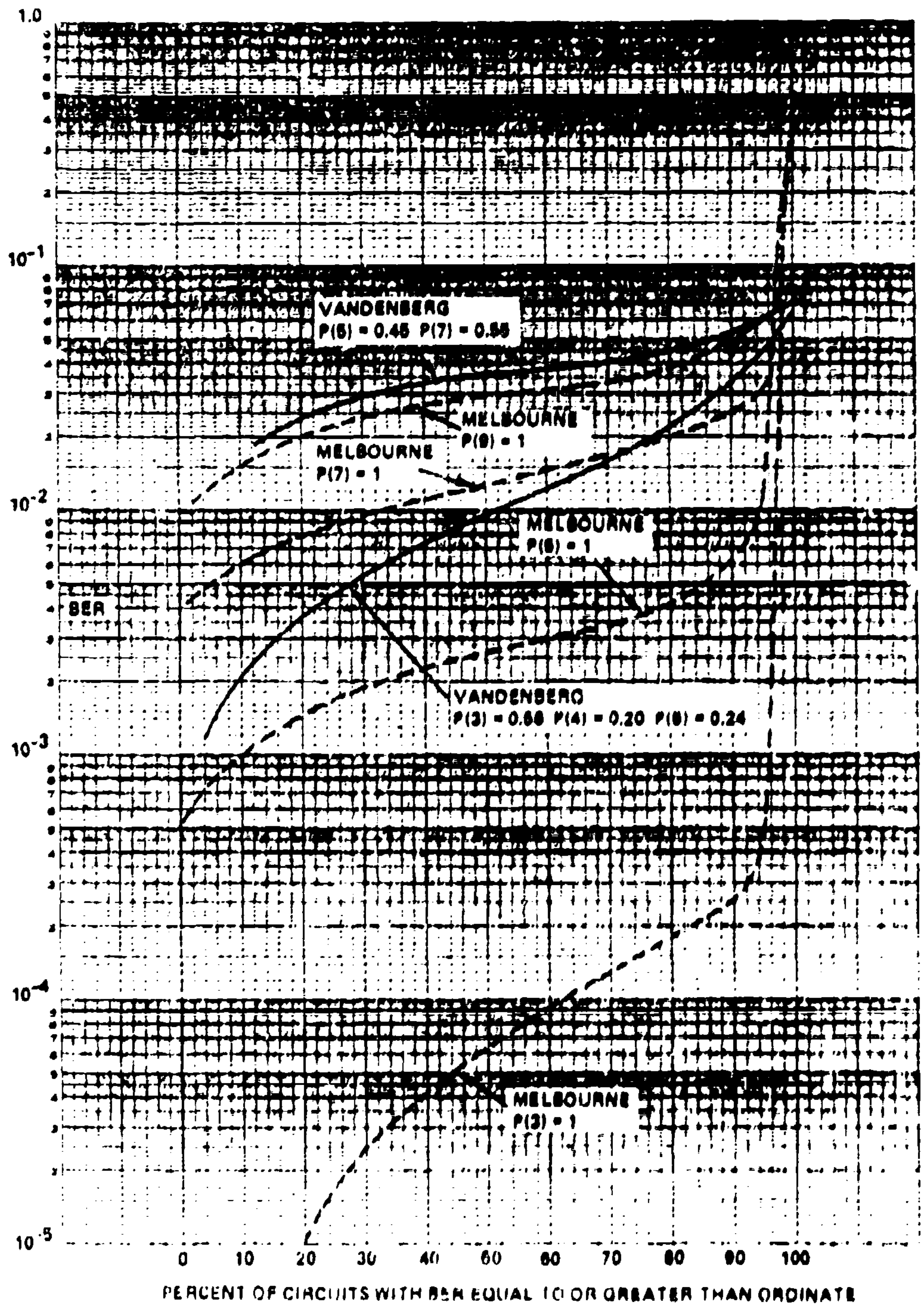


Figure 2.1.2.5-3. Comparison of Four-Wire Calls from Vandenberg and Melbourne

Unfortunately, some confusion existed during the site su[illegible] to the type of access lines available and it is not possible to ident[illegible] type of line for all calls. Table 2.1.2.6 lists the four-wire data from March. Figure 2.1.2.6-1 presents a histogram of this data. Figures 2.1.2.6-2 and 2.1.2.6-3 present cumulative results. It is anticipated that the relatively poor results shown are primarily due to the N2 carrier lines.

2.1.2.7 Four-Wire Calls From MacDill

The four-wire calls from MacDill represent a combination of Autosevocom calls and calls on the four-wire Autovon access lines from a General Telephone facility. Two Autosevocom lines are present, one homing on the Polk City switch and the other on the Ellisville switch. The four-wire Autovon lines also were dual homed on Polk City and Ellisville. In all cases the access lines were a combination of cable and LMX. The local loop data obtained was:

Loop to	Carrier Type	BER
POL	Cable-LMX	0
POL	Cable-LMX	0
ELL	Cable-LMX	3.0-5
POL	Cable-LMX	0
ELL	Cable-LMX	1.0-4 (Autosevocom circuit)

Table 2.1.2.7 lists the four-wire calls from MacDill. Figures 2.1.2.7-1 and 2.1.2.7-2 present a pictogram of this data. Figures 2.1.2.7-3 and 2.1.2.7-4 present cumulative results. In general these results are in line with those obtained from Melbourne.

Table 2.1.2.6. Four-Wire Calls From March

Normal Calls

P(3) = .64 P(4) = .36

MED BER

March	MELB
3.0-3	1.1-3
1.1-1	1.6-3
4.7-3	6.0-3
6.9-3	1.1-2
1.3-2	8.6-3
1.2-3	3.0-3

Loops

3-5 Switch	BER	P(3)	P(5)	5-7 Switch	BER	P(5)	P(7)	7-9 Switch	BER
MOJ-ARL	4.6-3	.32	.68	MOJ-[illegible]	1.4-2	.64	.36	MOJ-SHE	8.1-2
MOJ-[illegible]	6.0-3	.32	.68	MOJ-POL	1.6-2	.64	.36	MOJ-SPE	6.7-2
MOJ-NBD	8.6-4	.68	.32	MOJ-YAK	2.2-2	.53	.47		
JUL-ARL	7.9-3	.68	.32	MOJ-LYO	2.1-2	.65	.35		
				MOJ-CML	3.5-2	1.00	0		
				[illegible]	[illegible]	.21	.79		
				MOJ-FRI	2.0-2	.09	.91		
				MOJ-DOV	2.5-2	.51	.49		
				MOJ-CHI	1.4-2	.61	.39		
				[illegible]	[illegible]	[illegible]	.14		
				[illegible]	[illegible]	[illegible]	.46		
				[illegible]	[illegible]	[illegible]	[illegible]		
				[illegible]	[illegible]	[illegible]	[illegible]		

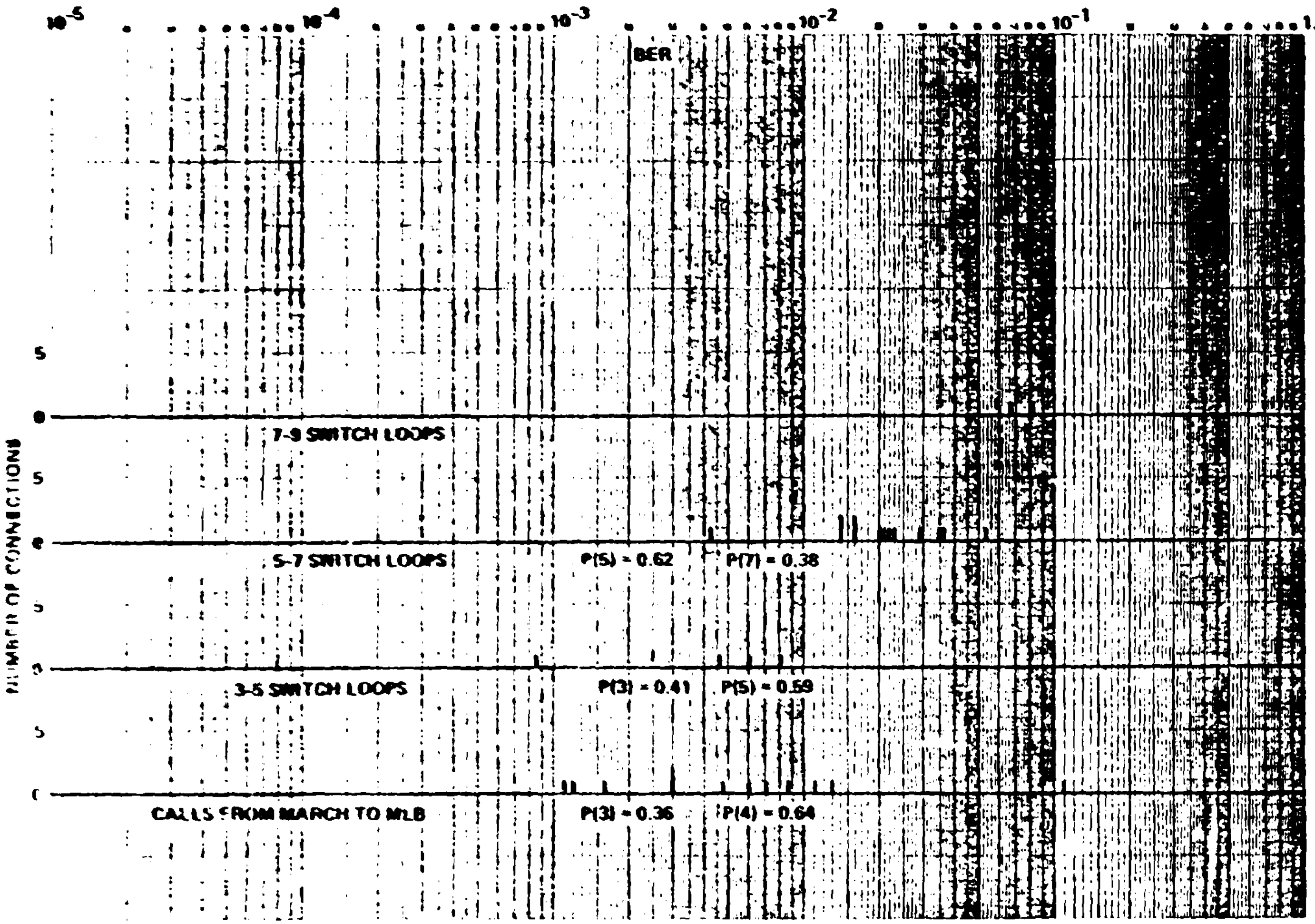
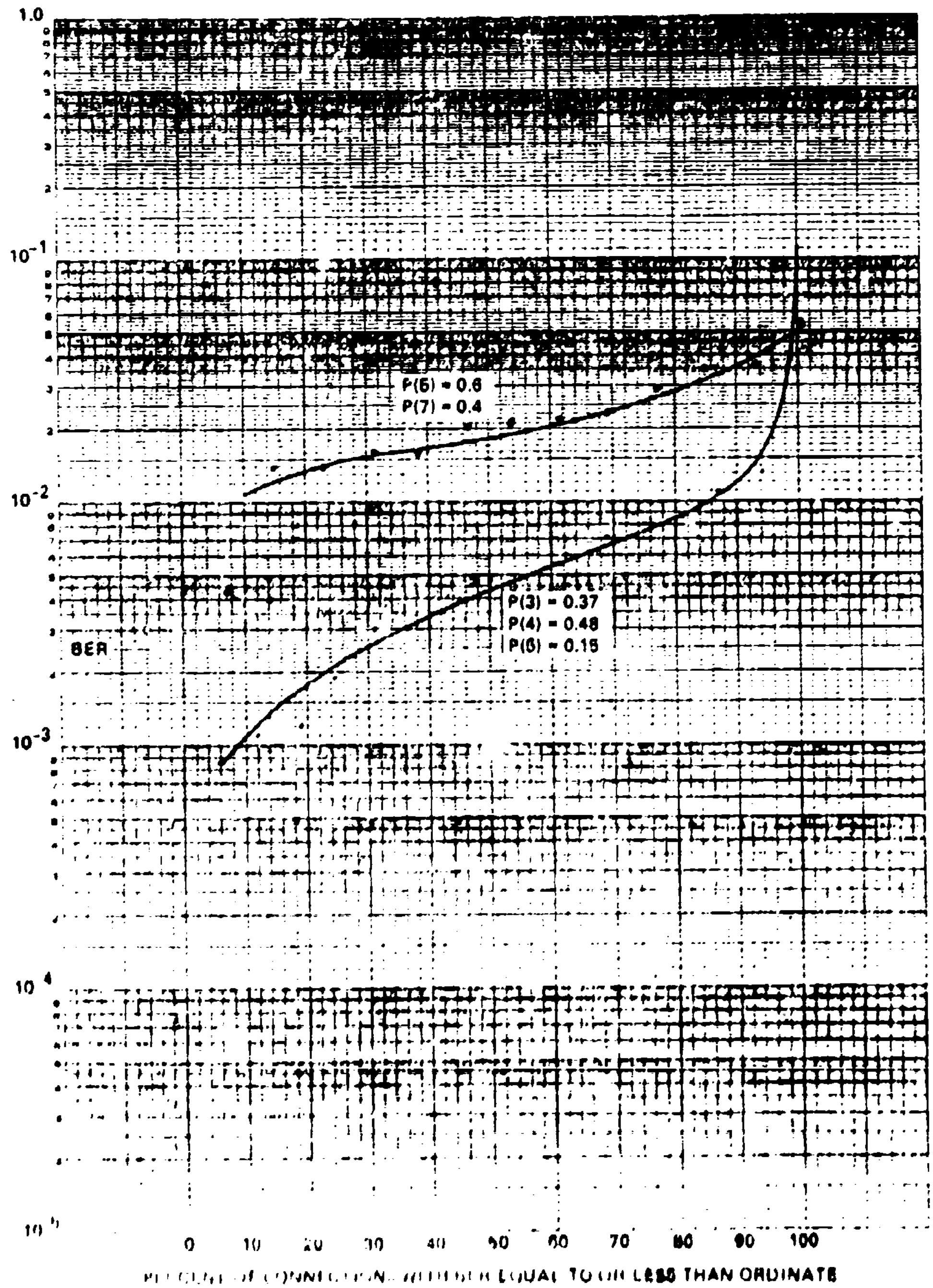


Figure 2.1.2.6-1. Four-Wire Calls From March (Histogram)



[illegible] From March AFB

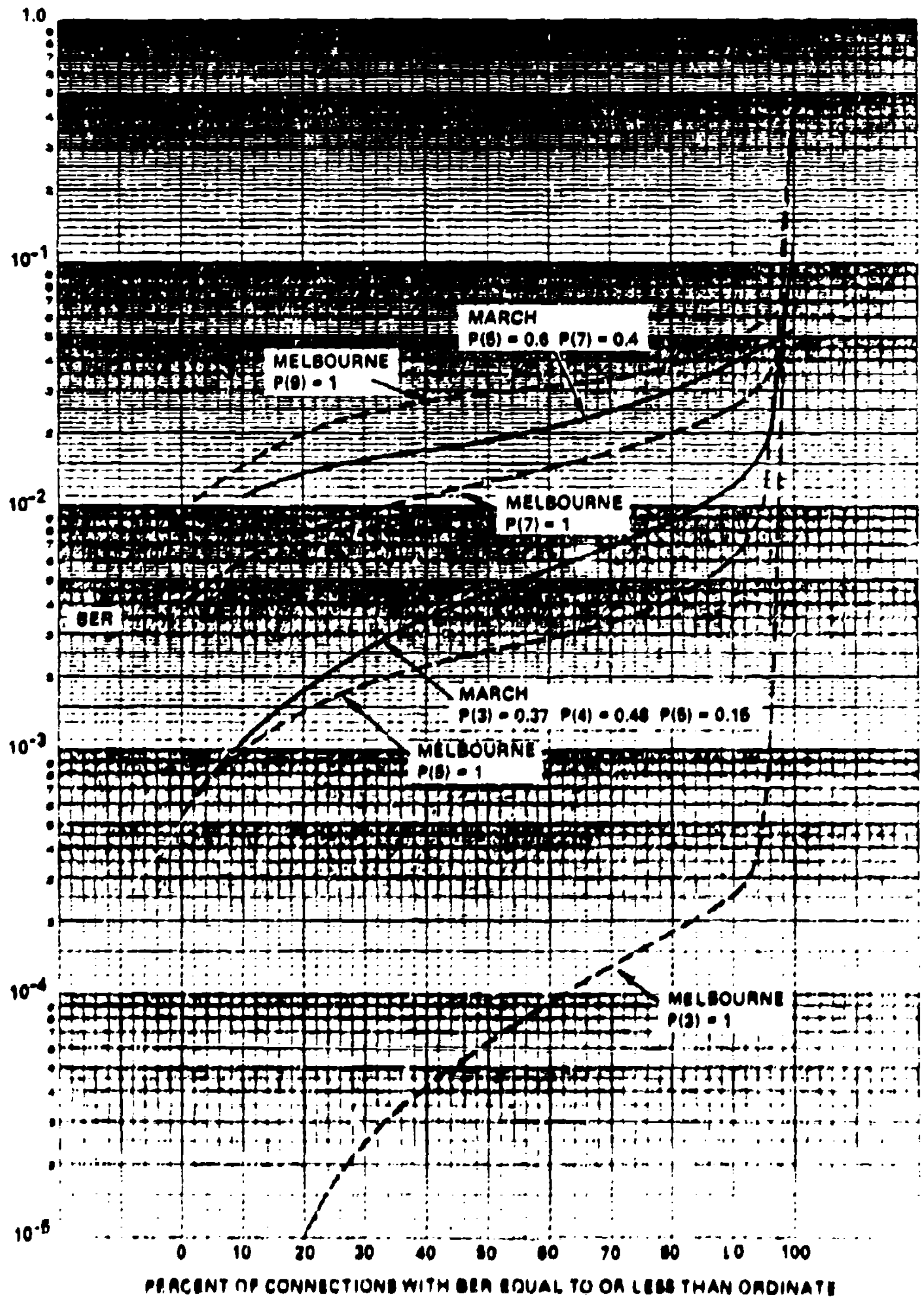


Figure 2.1.2.6-3. Comparison of Four-Wire Calls From March and Melbourne

Table 2.1.2.7. Four-Wire Calls From MacDill

P(1) = 1		P(2) = .73 P(3) = .27		P(2) = .81 P(3) = .19	
MED BER		MED BER (Via POL)		MED BER (Via ELL)	
MacD	MELB	MacD	Pent	MacD	Pent
2.0-5	3.1-4	3.9-4	4.4-5	7.0-5	0
3.0-5	1.2-4	1.9-3	6.2-6	3.0-5	6.2-6
0	0	1.9-3	1.2-5	7.0-5	2.5-5
2.0-5	0	7.7-4	0	7.0-5	0
1.3-5	6.9-4	1.8-3	4.4-5		
		1.7-3	1.0-4		
		1.5-3	1.6-4		
		1.1-3	1.1-4		
		2.7-3	1.4-4		
		7.3-4	1.6-4		

Loops

3-5 Switch	BER	P(3)	P(5)	5-7 Switch	BER	P(5)	P(7)	7-9 Switch	BER
POL-ARL	3.3-4	.73	.27	POL-HAG	1.4-2	.61	.39	ELL-YAK	2.7-2
POL-ARL	5.8-4	.73	.27	POL-LYO	5.7-3	.35	.65		
POL-ARL	1.1-4	.73	.27	POL-CMC	7.7-3	.17	.83		
ELL-POL	5.8-4	.84	.16	POL-NBD	3.0-2	.16	.84		
ELL-ARL	2.1-3	.81	.19	POL-NBD	4.3-2	.16	.84		
ELL-ARL	4.8-3	.81	.19	POL-NBD	8.6-2	.16	.84		
				POL-JUL	6.7-3	.42	.58		
				POL-JUL	9.1-3	.42	.58		
				POL-MOJ	1.2-2	.41	.59		
				POL-SLO	1.8-3	.43	.57		
				POL-YAK	1.1-2	.11	.89		
				POL-YAK	3.2-2	.11	.89		
				ELL-ARL	3.8-2	.21	.79		
				ELL-JUL	5.3-2	.56	.44		

Table 2.1.2.7. Four-Wire Calls From MacDill (Continued)

Dial Through

B1-5 Switch DT	Mcd BER	Remote BER	P(3)	P(4)	P(5)
ARL-SEG-POL	7.7-4	6.1-3	.63	.33	.04

4-7 Switch DT	Mcd BER	Remote BER	P(4)	P(5)	P(6)	P(7)
ARL-SEG-JAS-POL	8.0-3	1.4-2	.38	.49	.16	.02

6 - 9 Switch DT	Mcd BER	Remote BER	P(6)	P(7)	P(8)	P(9)
ELL-JAS-X-MOS-DRA-POL	2.1-2	2.1-2	.36	.46	.18	0
ELL-X-X-YAK-X-POL	4.1-2	9.4-2				
ARL-SEG-JAS-NOR-X-POL	6.2-2	4.4-2	.22	.43	.34	.01

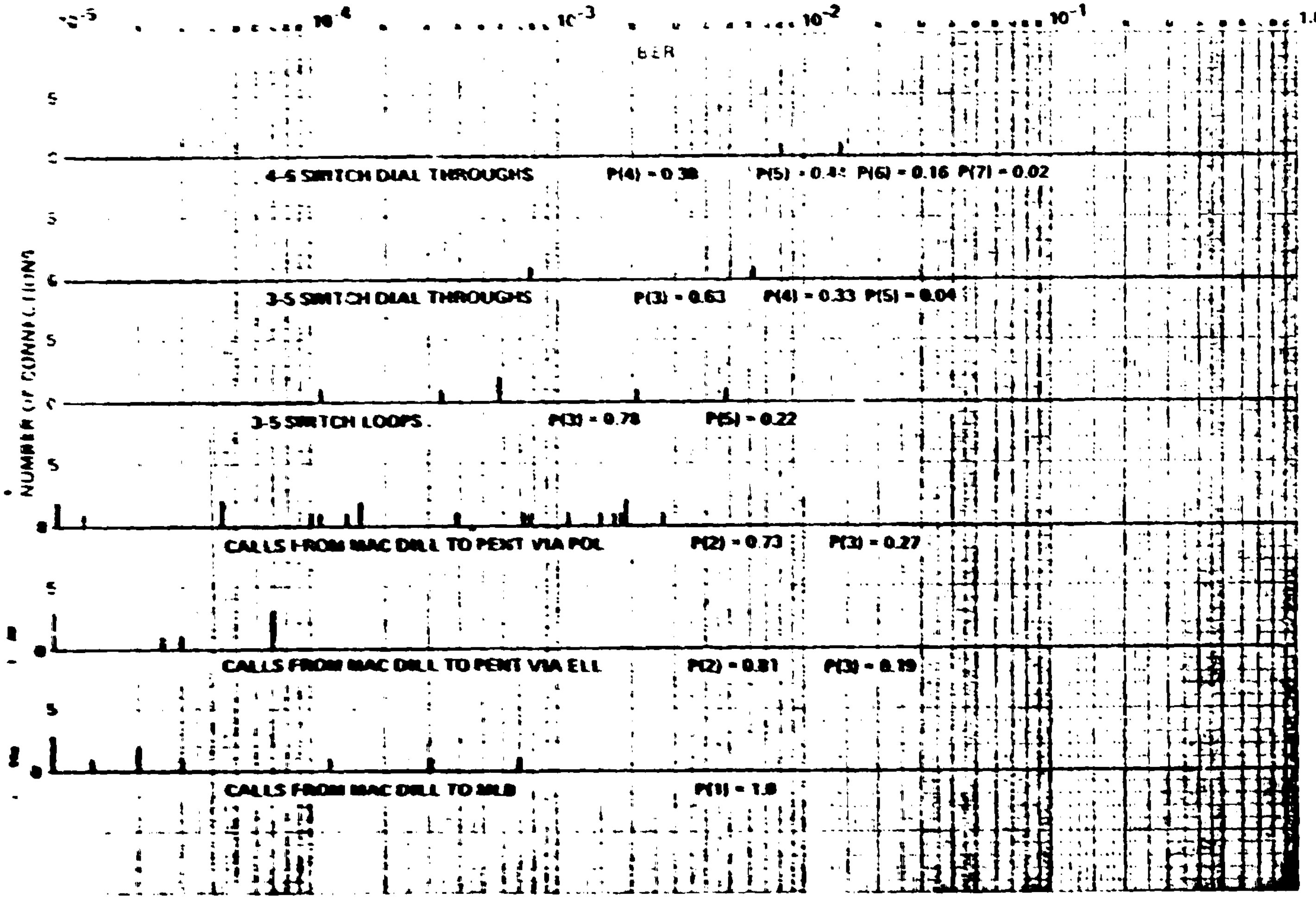


Figure 2.1.2.7-1. Four-Wire Calls From MacDill

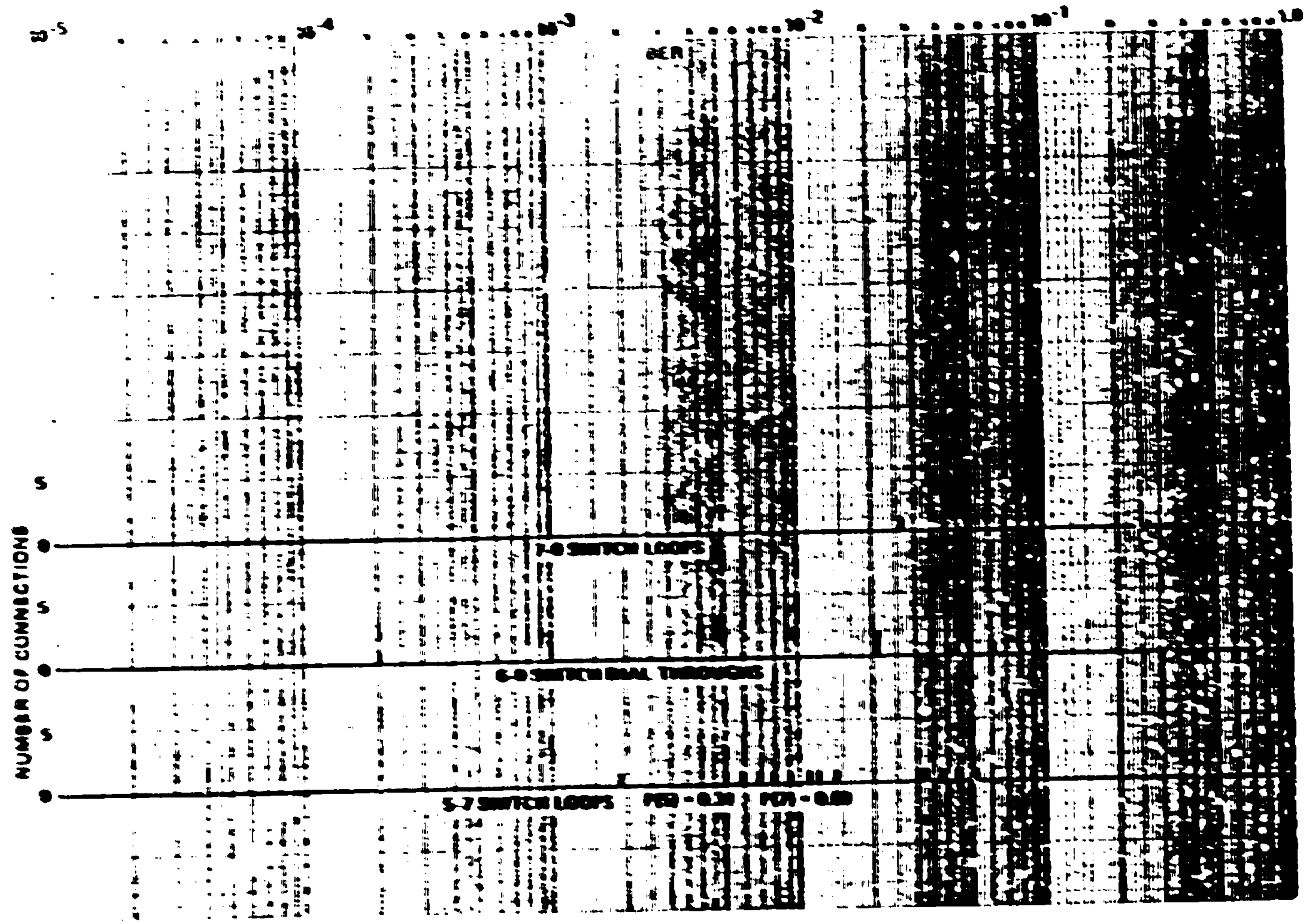


Figure 2.1.2.7-2. Four-Wire Calls From MacDill

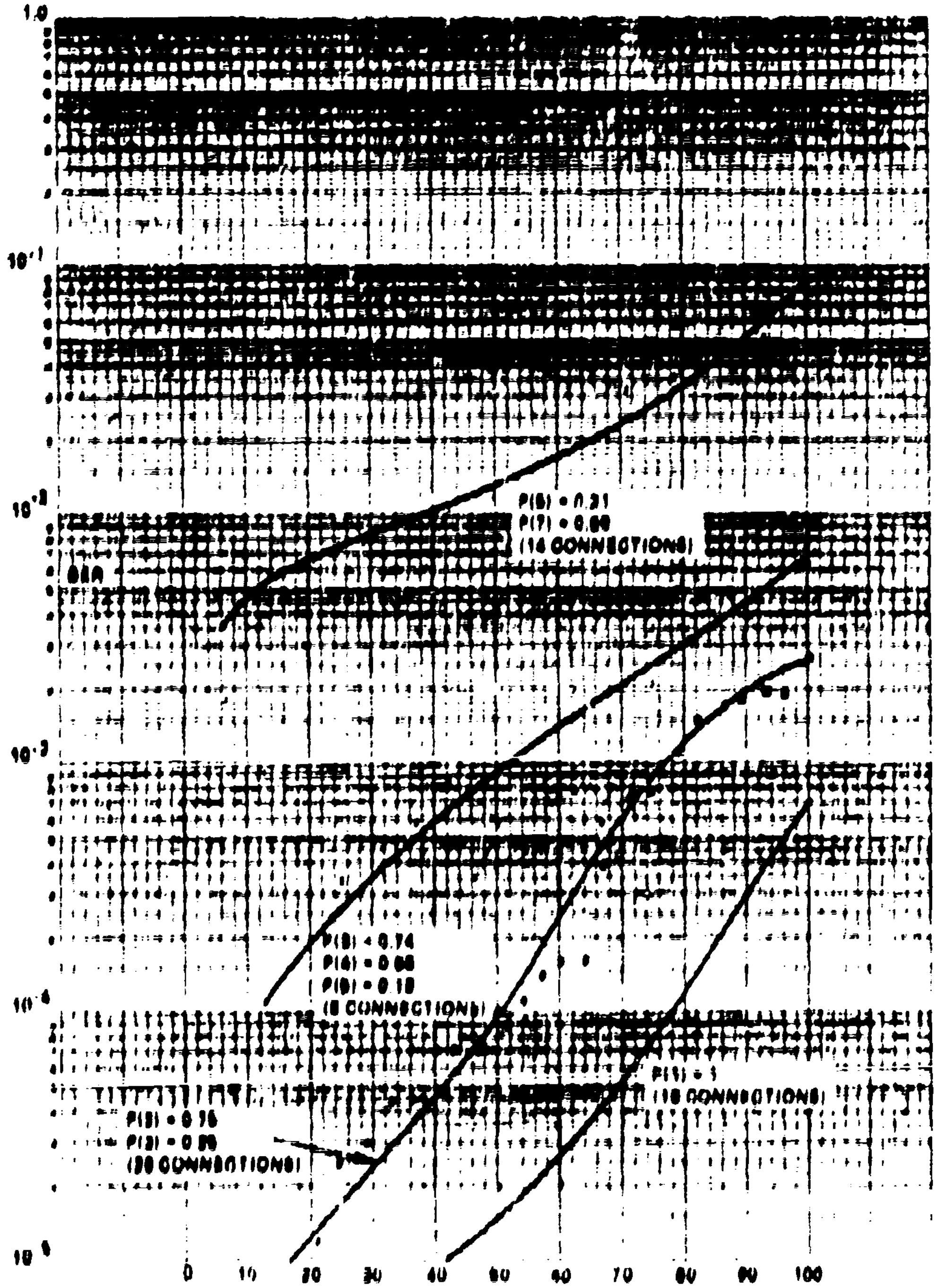


Figure 2.1.2.7-1. Calls from Marbill

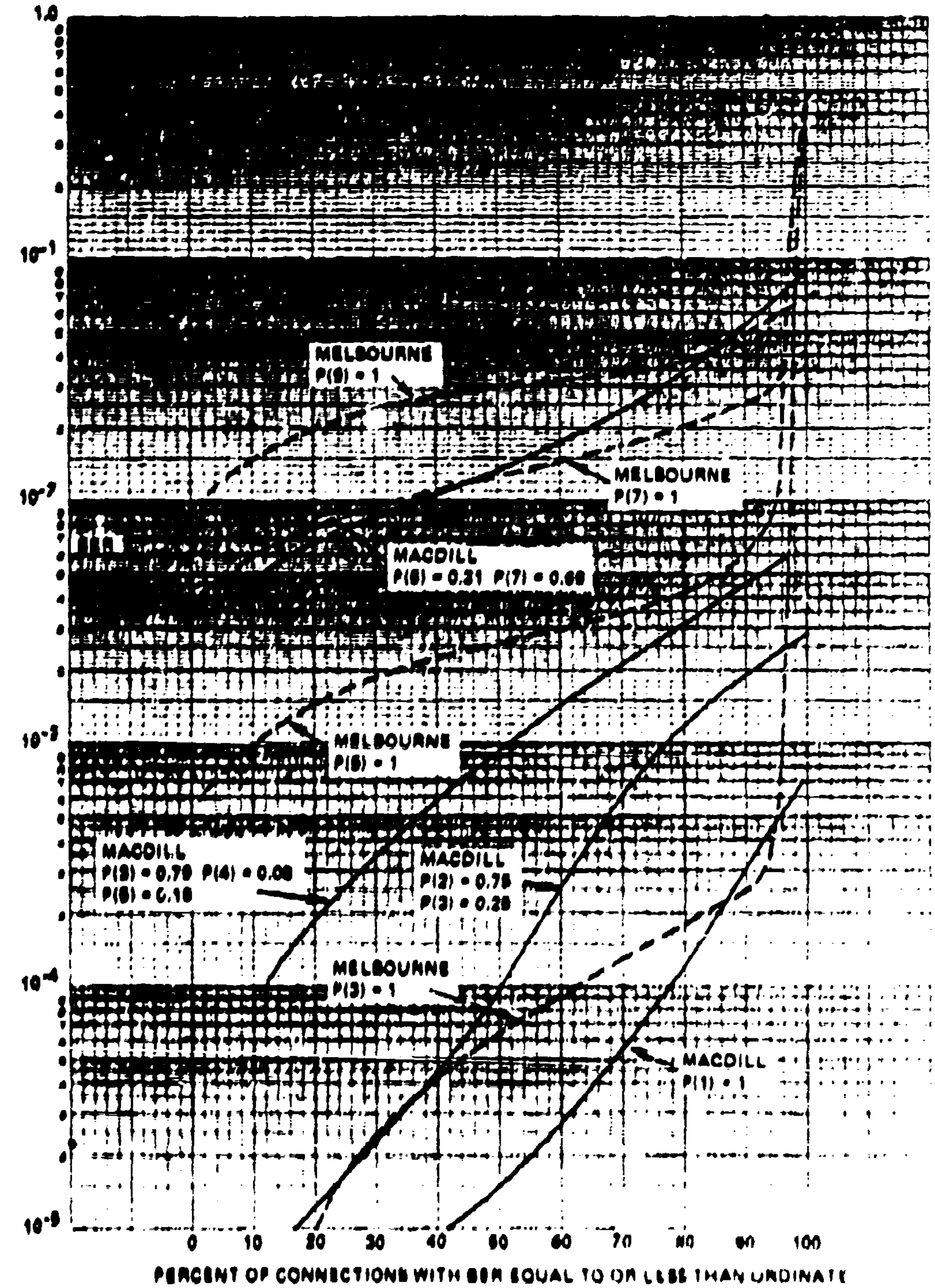


Figure 2.1.2.7-4. Comparison of Four-Wire Calls from MacDill

2.1.3 Results Involving Regenerators

All of the discussion presented thus far has considered an application in which the four-wire calls are placed from one subscriber to another via a direct-dialed network. The modem signal is thus routed through the network in whatever manner that the network switches dictate and the number of baseband conversions involved in the call will be a random variable.

A second type of use is one in which the modem is placed at each end of a dedicated circuit from either a remote subscriber to a digital switch or one digital switch to another. In this mode of operation, the number of baseband conversions in a modem connection would usually be two. Hence, a call placed in this type of network might involve several switches such as might be involved with the analog configuration, but the signals would be digitally regenerated at each switch. In this case the BER value involved in a particular call would be the sum of the BER values involved in each segment. Examination of Figure 2.1.1-7 indicates that digital tandeming of circuits using regenerators is considerably less damaging to BER performance than analog tandeming. Let us assume that a "worst-case" condition is assumed to be one in which seven tandem links were involved, each tandem link having an extra baseband conversion and each link operating at a BER corresponding to the ninety percentile value. (The probability of all seven being simultaneously this bad is .00001 percent.) In this case if we use three switch loop data from Melbourne we would predict an error rate of $5.4 \times 10^{-4} \times 7 = 3.7 \times 10^{-3}$ which is only slightly worse than the median value for an analog call involving five baseband conversions.

During Phase II data was taken involving normal calls from one site to another in which the signal was both analog and digitally looped back to the original location. Thus, the analog loop was equivalent to a case where extra baseband conversions were involved in the call whereas the digital loop represented the case where a regenerator was used at the center point of the circuit. The digital regeneration was accomplished by supplying the 16 kb/s decisions from the modem receiver to the transmitter port, thus supplying a digital loop.

Table 2.1.3 lists the error rates involved in these calls. In principle the digital loop BER values should equal the sum of the two individual connection error rates. The cases where this does not occur are probably due to variation in measured error rate as a function of time on the particular call. In any case, the analog BER values were generally a factor of five to ten worse than the loops involving regeneration.

2.1.4 Airborne Command Post Data

During Phase I four-wire loop-around tests were conducted from Offut, AFB to the airborne command post via Autovon lines. One looped call was placed on 15 March 1978 and three calls were placed on 16 March. The 16 kb/s BER on 15 March loop was 20 percent and the 8 kb/s BER was 8.8 percent. Considerable rapid amplitude fluctuation was noted indicating a multipath condition.

The BER values on 16 March were better. The 16 kb/s values were 6.5E-2, 4.7E-2 and 2.2E-2 while the 8 kb/s values were 5.1E-4, 5.8E-3 and 1.9E-3, respectively. Although amplitude fluctuation was still present on 16 March it was not as severe as that present on 15 March. The general

Table 2.1.3. Comparison of Digital and Analog Regenerators

Offut BER	Pentagon BER	Digital Loop BER	Analog Loop BER
1.2E-3	8.9E-3	1.7E-3	3.0E-2
7.6E-3	5.9E-3	1.6E-2	8.4E-2
4.4E-4	1.0E-3	2.1E-3	2.4E-2
5.3E-4	4.9E-3	5.7E-3	2.8E-2
6.7E-4	4.3E-3	5.6E-3	2.4E-2
2.8E-3	2.9E-3	3.7E-3	2.2E-2
7.6E-2	1.3E-2	5.3E-2	1.0E-1(Triple Dial Through)

MacDill BER	Pentagon BER	Digital Loop BER	Analog Loop BER
1.9E-3	1.2E-5	4.5E-3	1.3E-2
7.7E-4	0	1.8E-3	1.5E-3
1.8E-3	4.4E-5	4.3E-3	2.1E-2
1.7E-3	1.0E-4	1.7E-3	1.9E-2
1.5E-3	1.6E-4	1.1E-3	2.7E-2
1.1E-31	1.1E-4	2.0E-3	2.0E-2
2.7E-3	1.4E-4	1.3E-3	2.8E-2
7.3E-4	1.6E-4	4.9E-4	4.5E-2

conclusion that was drawn from these tests is that although it is felt that the modem could be designed to function satisfactorily over the channel to the airborne command post, in its present configuration it is incapable of satisfactorily combatting the dynamic multipath conditions encountered.

2.2 Two-Wire Data

Although the principal interest of the test program was to determine modem operation on the CONUS four-wire Autovon network, a separate objective was to determine if modem performance was damaged when it was operated from two-wire points in the network. In this case, the modem had to contend with the four-wire to two-wire hybrids which convert the four-wire Autovon access line to a two-wire PBX circuit as well as the PBX and the lines interfacing it. Paragraph 2.2.1 will present the 16 kb/s results on two-wire Autovon calls, almost all of which was obtained during Phase II. Paragraph 2.2.2 will present the 16 kb/s results obtained from commercial calls during both Phase I and Phase II. Paragraph 2.2.3 will discuss results obtained at rates of 9.6 kb/s and 8 kb/s.

2.2.1 Autovon Two-Wire Data at 16 Kb/s

The data gathered relative to two-wire Autovon operations was obtained almost entirely during Phase II. Hence, the sites involved are MacDill, Offut, March, Pentagon, and Ft. Meade. Data from these sites will be considered separately. In addition, two-wire data taken during Phase I will be listed in Paragraph 2.2.1.6.

2.2.1.1 Two-Wire Data from MacDill-Pentagon

The two-wire data from MacDill was obtained from 2 two-wire phone connections on the subscriber side of the PBX. During the majority of the tests it was noted that the BER values recorded at MacDill tended to be worse than those recorded at the Pentagon. However, it was not until the fourth day that local loop tests indicated the nature of the problem and not until the fifth or last day of tests that the solution around the problem was discovered.

The GP Autovon access lines from MacDill all homed on Polk City. However some of these lines are routed through the SAGE Building at MacDill and others rou..d directly to downtown Tampa. It was found that access loops to Polk City exhibited satisfactory error rates on lines routed through the SAGE Building whereas the BER measured on the access loops on the lines going directly to Tampa were very poor. Table 2.2.1.1-1 lists BER values obtained on seven different two-wire access loops. The reason for the poor performance on the Tampa lines was found to be a large amount of reflection, apparently from mismatches at the hybrid locations.

Table 2.2.1.1-1. Comparison of BER Values on Two Access Loops as a Function of Routing

Looped at Polk City Through SAGE Building	Looped at Polk City Through Tampa	Looped at Polk City Out SAGE In Tampa
BER	BER	BER
1.9E-4	1.5E-1	4.6E-3
5.2E-4	5.1E-2	
	1.0E-1	
	1.1E-1	

Note that bad error rates on the Tampa routing were caused by reflections. These cleared up by either disconnecting the unused pair of the four-wire pair involved in Polk City or by better matching the impedance of the transmit or receive modem.

It was discovered, however, that by providing a pad at the modem the BER values on the Tampa loops could be reduced to those comparable to the SAGE loops. Since the modem was designed primarily for four-wire operation the line loading had not previously been found to be a problem. However, unquestionably it was a problem at MacDill and undoubtedly

contributed to the relatively poor BER performance measured at MacDill on the two-wire tests. The BER performance at the Pentagon was likely to be affected also but appeared to be less damaged than the measurements at MacDill. The modem loading was modified for the remaining tests so that it presented a 600 ohm resistive load to the circuits involved. It is anticipated that two-wire performance at MacDill would be considerably improved if the modem had been better matched for those tests.

Table 2.2.1.1-2 lists the two-wire long distance data obtained on calls from MacDill to the Pentagon. As with the four-wire data, an estimate is made as to the probable number of Autovon switches involved in the calls. In most of the two-wire data the Autovon switches at one or both ends of the transmission was not known since all of the locations except MacDill and Ft. Meade were dual homed. The probabilities relating to the number of switches involved have been obtained by averaging over the routes involving the possible end switches assuming those switches are equally likely to occur.

Figures 2.2.1.1-1 and 2.2.1.1-2 show a histogram presentation of the data in Table 2.2.1.1-1. Figures 2.2.1.1-3 and 2.2.1.1-4 show cumulative values of BER measured at MacDill and at the Pentagon. Figure 2.2.1.1-5 compares this two-wire data with the four-wire data obtained from MacDill. As can be seen the two-wire performance measured at MacDill is relatively poor, undoubtedly due to reflections on calls which were not routed through the SAGE facility. The BER performance at the Pentagon appears to be slightly worse that the four-wire performance but not nearly as bad as that measured at MacDill.

Table 2.2.1.1-2. Two-Wire Calls From MacDill-Pentagon

Normal Calls

P(2) = 0.70 P(3) = 0.30

MED BER MacDill	MED BER Pentagon
2.2-3	-
1.9-3	8.2-4
2.2-3	1.8-4
2.1-3	5.0-4
3.1-3	3.0-4
2.8-3	6.9-4
2.7-3	7.8-4
7.1-2	-
3.5-3	1.2-3
4.2-2	-
9.8-3	3.6-3

P(2) = 0.70 P(3) = 0.30

MED BER MacDill	MED BER Pentagon
3.5-2	-
3.1-2	-
6.0-4	1.0-3
2.1-5	1.2-3
4.6-4	9.9-4
3.2-4	5.8-4
1.0-3	3.2-4
4.8-3	4.7-4
2.0-3	9.0-5
-	3.7-4
2.7-3	1.9-3

P(2) = 0.70 P(3) = 0.30

MED BER MacDill	MED BER Pentagon
2.7-3	2.2-3
2.9-4	2.3-4
2.5-3	5.0-4
2.0-3	5.3-3
1.6-2	8.5-4
2.0-4	1.7-4
9.7-4	3.5-4
2.6-3	1.2-2
1.2-2	-
4.0-3	2.0-4
1.2-4	6.5-4

P(2) = 0.70 P(3) = 0.30

MED BER MacDill	MED BER Pentagon
7.3-4	8.4-4
1.2-2	7.0-4
2.1-1	5.4-3
2.6-2	8.1-4
4.1-3	9.8-4
-	1.2-2
4.5-3	1.4-3
8.8-4	4.0-3
3.7-2	1.0-4
4.2-2	3.0-4
2.0-3	5.4-4
2.0-1	-

Dial Throughs

3-5 Switch DT	MacDill BER	Pentagon BER	P(3)	P(4)	P(5)
POL-JAS-X	4.7-3	3.5-3	0.62	0.31	0.07
POL-JAS-X	1.1-1	2.6-2	0.62	0.31	0.07
POL-SEG-X	4.3-2	8.7-3	0.68	0.27	0.05

4-7 Switch DT	MacDill BER	Pentagon BER	P(4)	P(5)	P(6)	P(7)
POL-SEG-JAS-X	3.5-2	8.4-3	0.40	0.44	0.15	0.01
POL-SEG-SLO-X	5.9-2	-	0.17	0.42	0.34	0.07
POL-SEG-SLO-X	1.3-1	7.5-3	0.17	0.41	0.34	0.07

Table 2.2.1.1-2. Two-Wire Calls From MacDill-Pentagon (Continued)

Dial Throughs

5-8 Switch DT	MacDill BER	Pentagon BER	P(5)	P(6)	P(7)	P(8)
POL-JAS-NOR-MOS-X	3.6-2	2.6-2	0.21	0.43	0.30	0.06
POL-JAS-NOR-MOS-X	1.3-1	3.8-2	0.21	0.43	0.30	0.06

6-10 Switch DT	MacDill BER	Pentagon BER	P(6)	P(7)	P(8)	P(9)	P(10)
POL-SEG-SLO-X-NOR-X	1.8-1	7.5-2	0.13	0.35	0.35	0.15	0.02

2.2.1.2 Two-Wire Data from Offut

The GP Autovon access lines from Offut homed on the Lyons, Nebraska and Fairview, Kansas Autovon switches. Figure 2.2.1.2-1 shows the percent of two-wire access loops from Offut that achieved the specified BER or better. These results are not inconsistent with the four-wire access results from Offut.

Table 2.2.1.2-1 lists the two-wire long distance calls from Offut to the Pentagon. Figure 2.2.1.2-2 shows a histogram of these calls. It is interesting to note that calls through the Fairview switch could reach the Pentagon switches (Arlington or Drainsville) without an intervening switch. Calls through Lyons, however, required an intervening switch. The normal calls are subdivided into three groups: those known to be via Lyons, those known to be via Fairview and those where the switch at the Offut end was not identified. Figure 2.2.1.2-3 shows the cumulative distribution of these calls where those which have a minimum of 2, 3 or 4 switches have been combined. Figure 2.2.1.2-4 shows a comparison of this data with four-wire data from Offut. If the probabilities associated with the number of switches on the lines are taken into account, the two- and four-wire performance at Offut appears to be about the same.

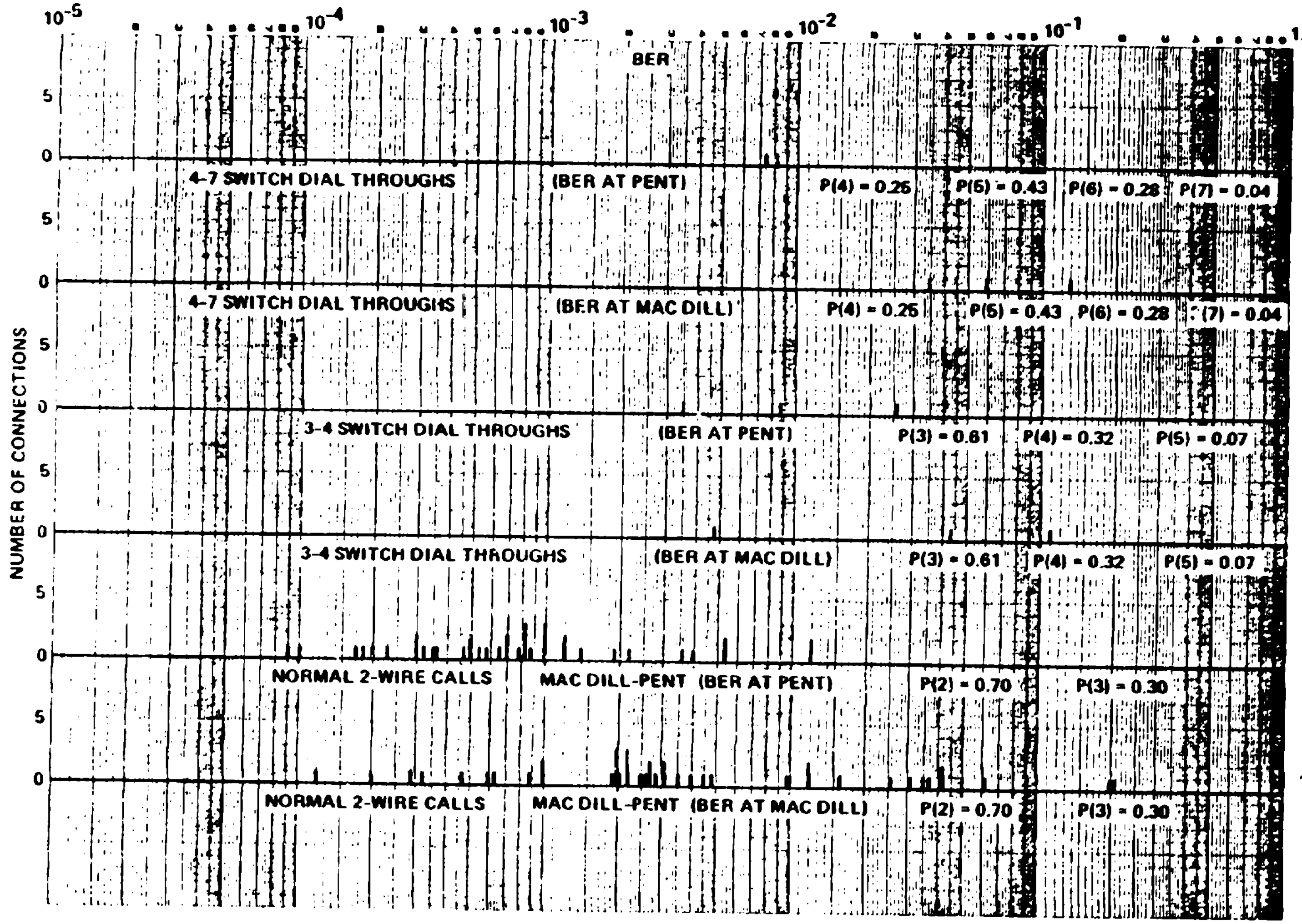


Figure 2.2.1.1-1. Two-Wire Calls at MacDill (Histogram)

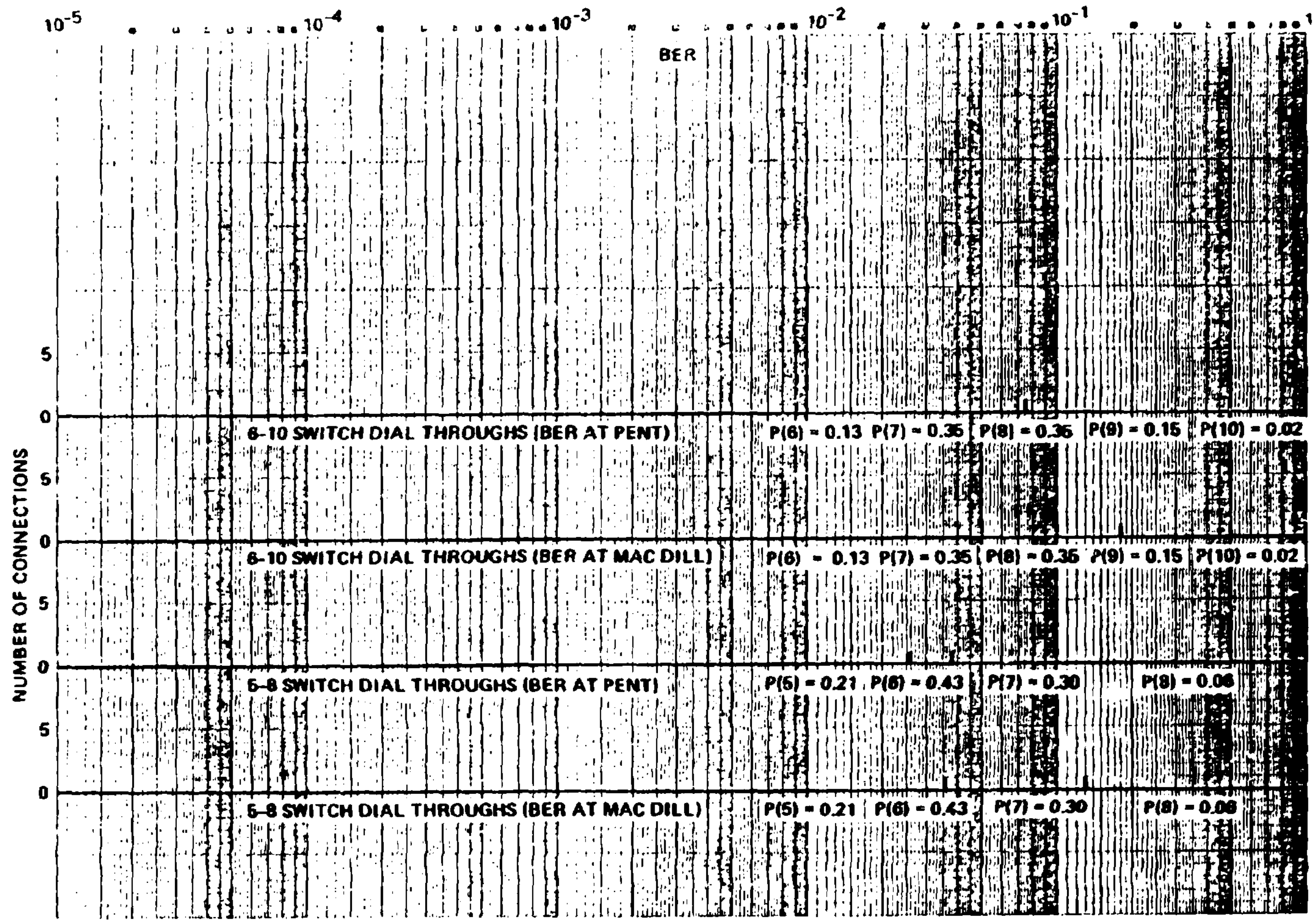


Figure 2.2.1.1-2. Two-Wire Calls at MacDill (Histogram)

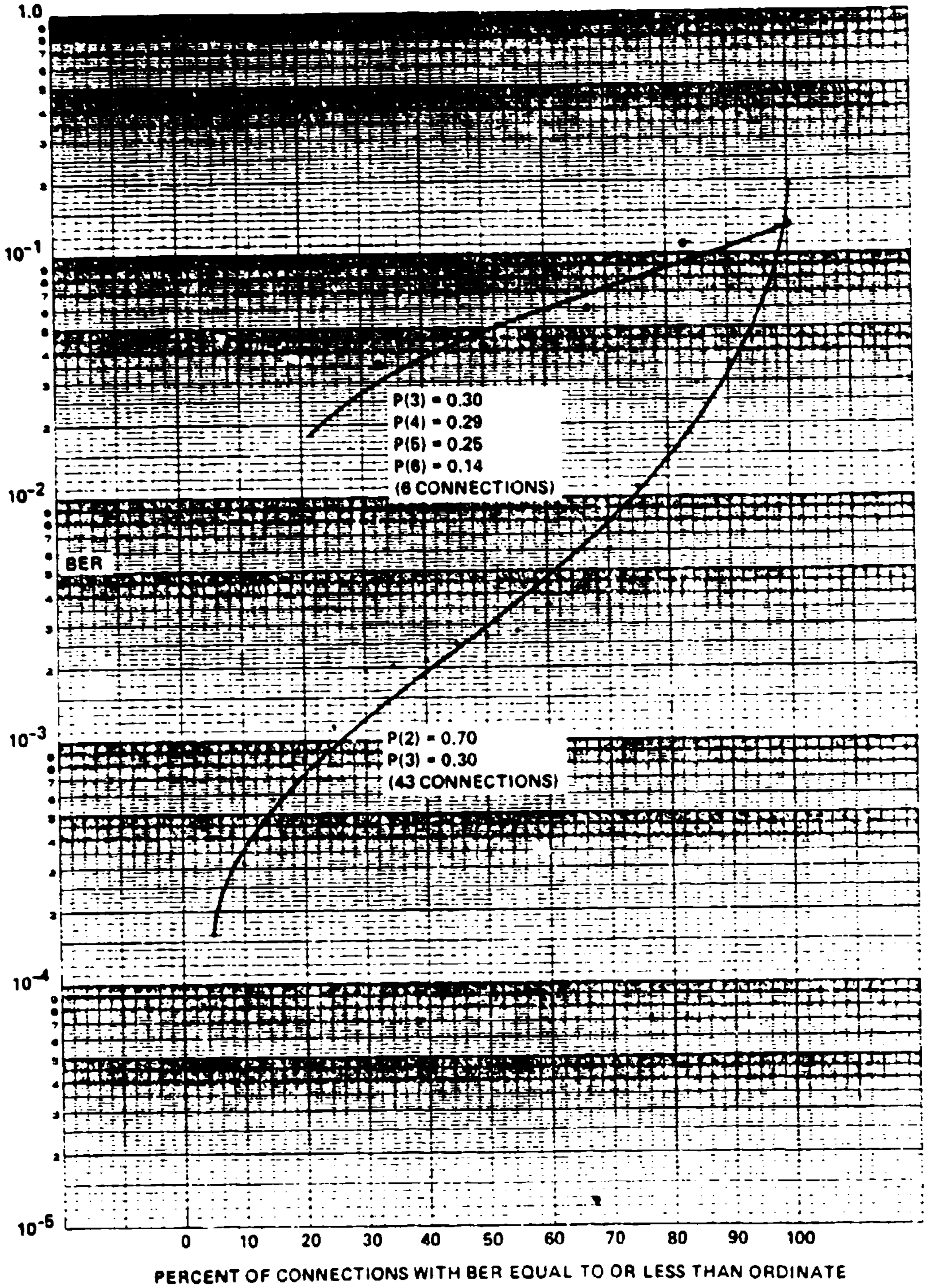


Figure 2.2.1.1-3. Two-Wire Connections From MacDill To Pentagon (BER at MacDill)

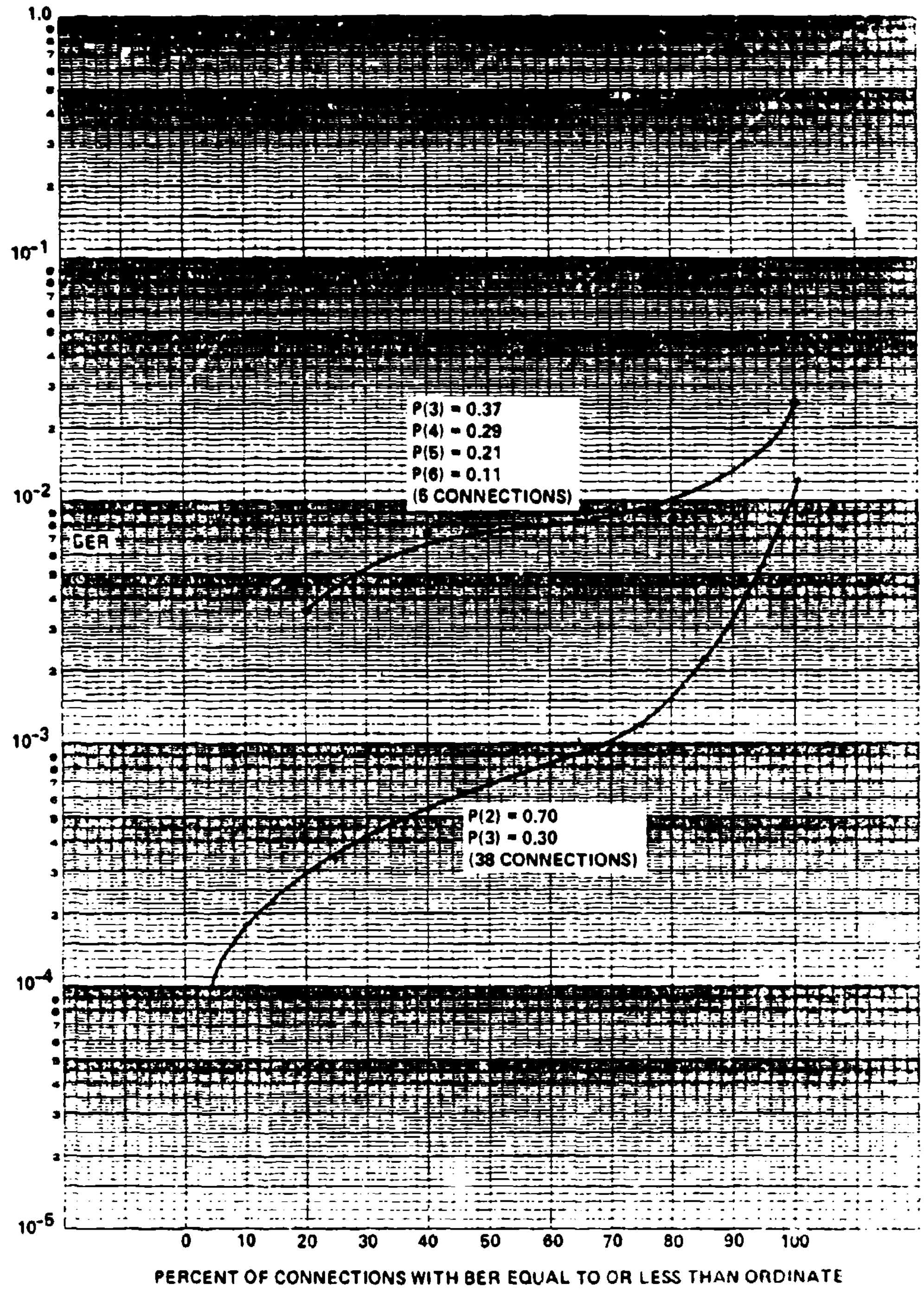


Figure 2.2.1.1-4. Two-Wire Calls From MacDill To Pentagon (BER at Pentagon)

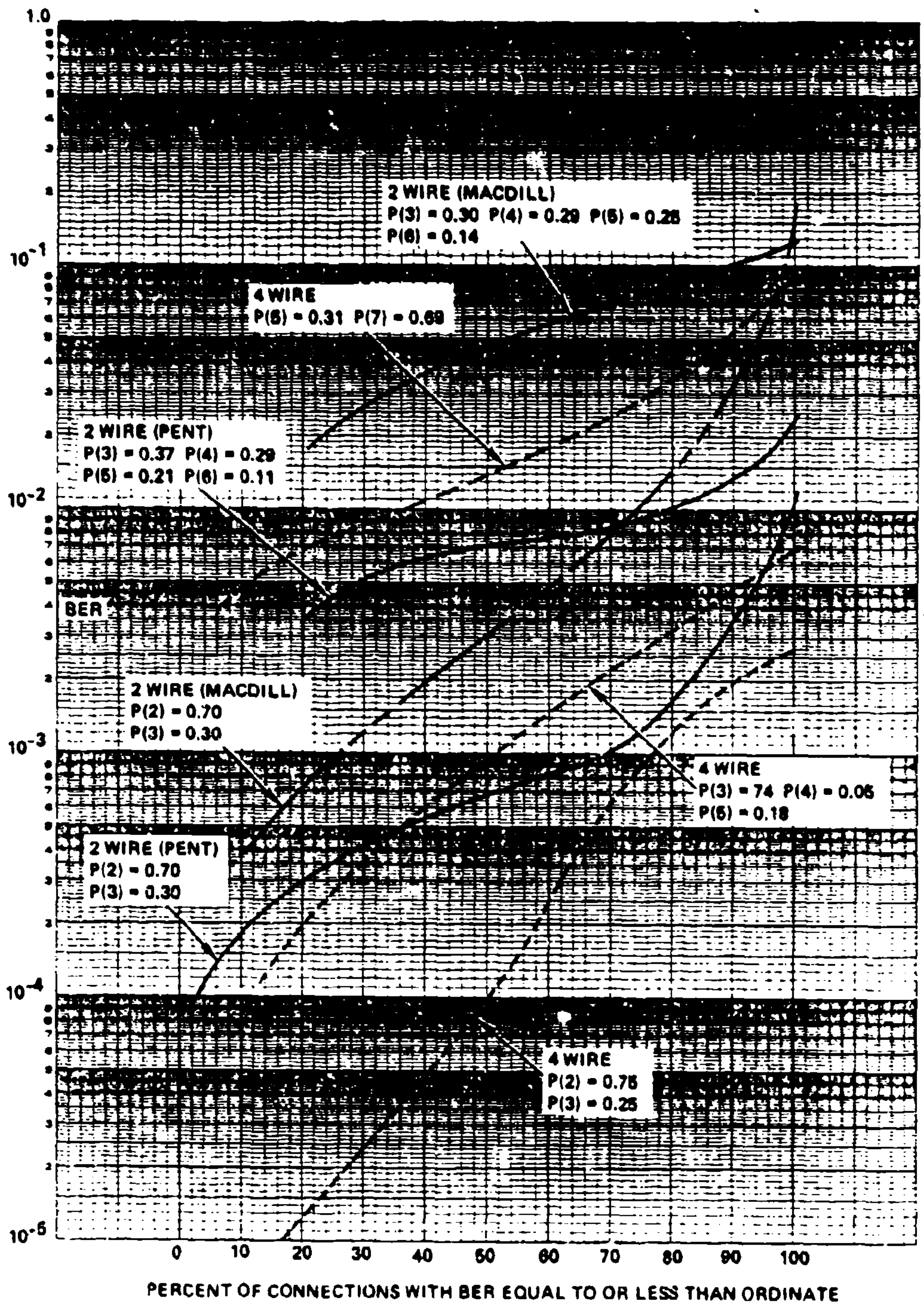


Figure 2.2.1.1-5. Comparison of Two- and Four-Wire Calls From MacDill

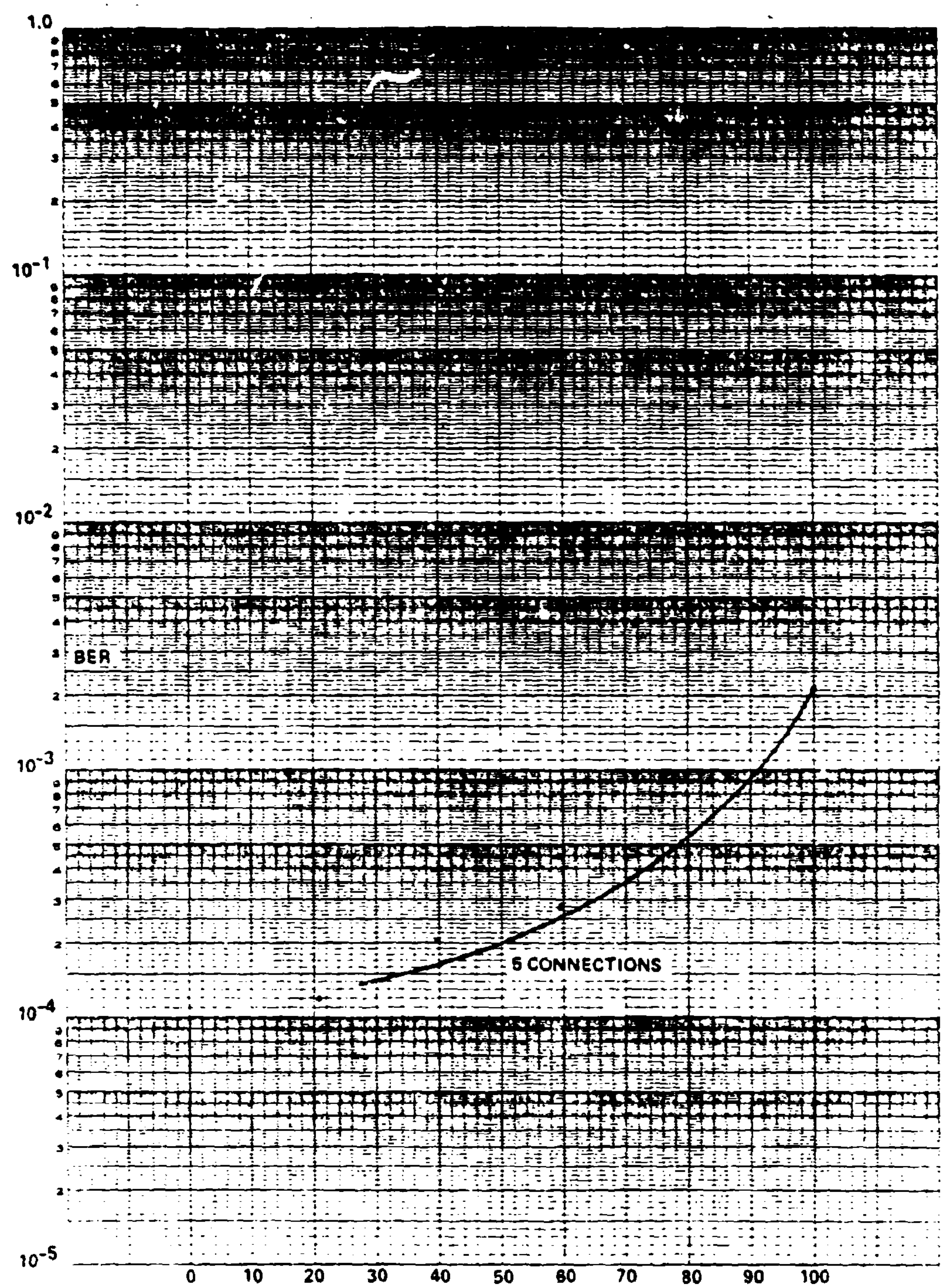


Figure 2.2.1.2-1. Two-Wire Access Loops at Offut

Table 2.2.1.2-1. Two-Wire Calls From Offut-Pentagon

Normal Calls

MED BER (Via FVW)		MED BER (Via LYO)		MED BER (Via ?)	
Offut	Pentagon	Offut	Pentagon	Offut	Pentagon
1.4-3	2.2-3	8.7-2	2.3-2	5.9-4	3.1-4
3.2-3	2.7-4	3.1-3	2.1-3	2.6-2	1.2-2
2.2-4	1.2-3	5.6-4	2.7-3	2.3-4	2.5-4
5.2-4	6.8-4	1.7-3	6.2-3	5.3-4	2.8-4
1.6-3	1.3-3	9.1-3	2.4-3	3.1-3	7.6-3
2.3-3	3.3-3	2.3-3	1.4-3	6.0-5	5.5-4
4.0-4	5.1-4	2.8-3	1.0-3	3.0-5	9.0-5
4.1-4	2.4-3	1.4-3	5.1-3	7.6-4	2.8-3
1.2-2	1.1-2	3.7-3	8.5-3	1.2-2	1.5-4
3.1-3	6.1-4	1.2-3	1.0-4	3.1-4	0
2.1-3	5.6-3	7.3-3	6.4-3	8.0-5	2.5-4
8.7-4	6.2-4	2.2-3	8.2-3	5.7-4	2.0-4
4.7-4	3.4-4			2.1-3	
3.7-4	2.0-4				
3.7-4	4.2-4				
1.9-4	3.2-4				
3.4-4	1.5-4				

Dial Throughs

3-5 Switch DT	Offut BER	Pentagon BER	P(3)	P(4)	P(5)
X-NOR-X	1.5-3	2.0-3	0.36	0.48	0.16
X-NOR-X	1.4-3	1.9-3	0.36	0.48	0.16
X-NOR-X	3.1-3	1.2-3	0.36	0.48	0.16
X-NOR-X	-	1.4-1	0.36	0.48	0.16
X-NOR-X	1.8-4	5.4-4	0.36	0.48	0.16
X-SEG-X	8.0-4	4.0-3	0.62	0.34	0.04
ARL-SEG-FVW	7.3-4	3.1-3	0.69	0.28	0.03

Table 2.2.1.2-1. Two Wire Calls From Offut-Pentagon (Continued)

4-7 Switch DT	Offut BER	Pentagon BER	P(4)	P(5)	P(6)	P(7)
X-MOS-NOR-X	1.0-3	3.3-3	0.36	0.48	0.16	0
X-JAS-X-X	4.4-3	8.3-3	0.53	0.41	0.06	0
X-MON-SEG-FVW	6.0-3	3.1-2	1.0	0	0	0
X-JAS-NOR-X	2.7-3	1.5-2	0.24	0.45	0.27	0.04
X-POT-MOS-X	2.6-3	4.9-3	0.27	0.39	0.27	0.07
X-JAS-NOR-X	6.3-3	1.2-2	0.24	0.45	0.27	0.04
X-JAS-NOR-X	5.9-3	6.3-3	0.24	0.45	0.27	0.04
X-JAS-NOR-X	5.7-3	1.0-2	0.24	0.45	0.27	0.04
X-SLO-SEG-X	7.8-4	6.6-4	0.17	0.43	0.33	0.07
X-SLO-SEG-X	2.4-1	2.6-2	0.17	0.43	0.33	0.07
X-SLO-SEG-X	1.1-3	6.5-3	0.17	0.43	0.33	0.07
X-SLO-SEG-X	6.1-3	8.5-3	0.17	0.43	0.33	0.07
X-JAS-SEG-X	4.9-3	1.6-1	0.42	0.39	0.17	0.02
X-MOS-NOR-X	-	2.1-2	0.36	0.48	0.16	0
X-SLO-SEG-X	-	2.3-3	0.17	0.43	0.33	0.07
X-JAS-NOR-X	-	1.4-2	0.24	0.45	0.27	0.04

5-8 Switch DT	Offut BER	Pentagon BER	P(5)	P(6)	P(7)	P(8)
X-POT-MOS-NOR-X	3.6-2	4.8-2	0.23	0.44	0.27	0.06
X-POT-MOS-NOR-X	2.0-2	2.2-2	0.23	0.44	0.27	0.06

7-11 Switch DT	Offut BER	Pentagon BER	P(7)	P(8)	P(9)	P(10)	P(11)
X-JAS-NOR-X-YAK-X-X	1.4-1	7.1-2	0.01	0.20	0.45	0.29	0.05

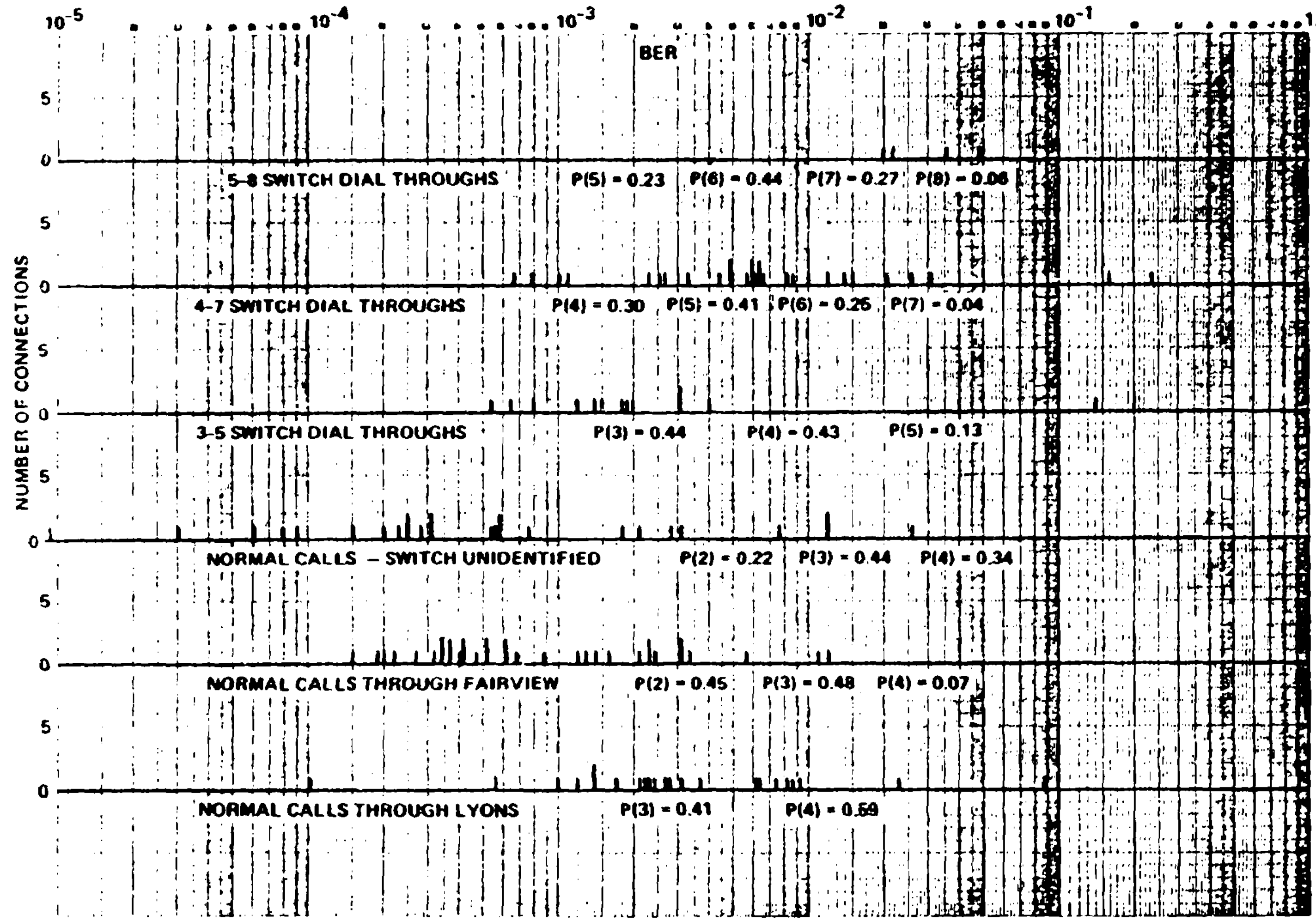


Figure 2.2.1.2-2. Histogram of Two-Wire Calls From Offut to Pentagon

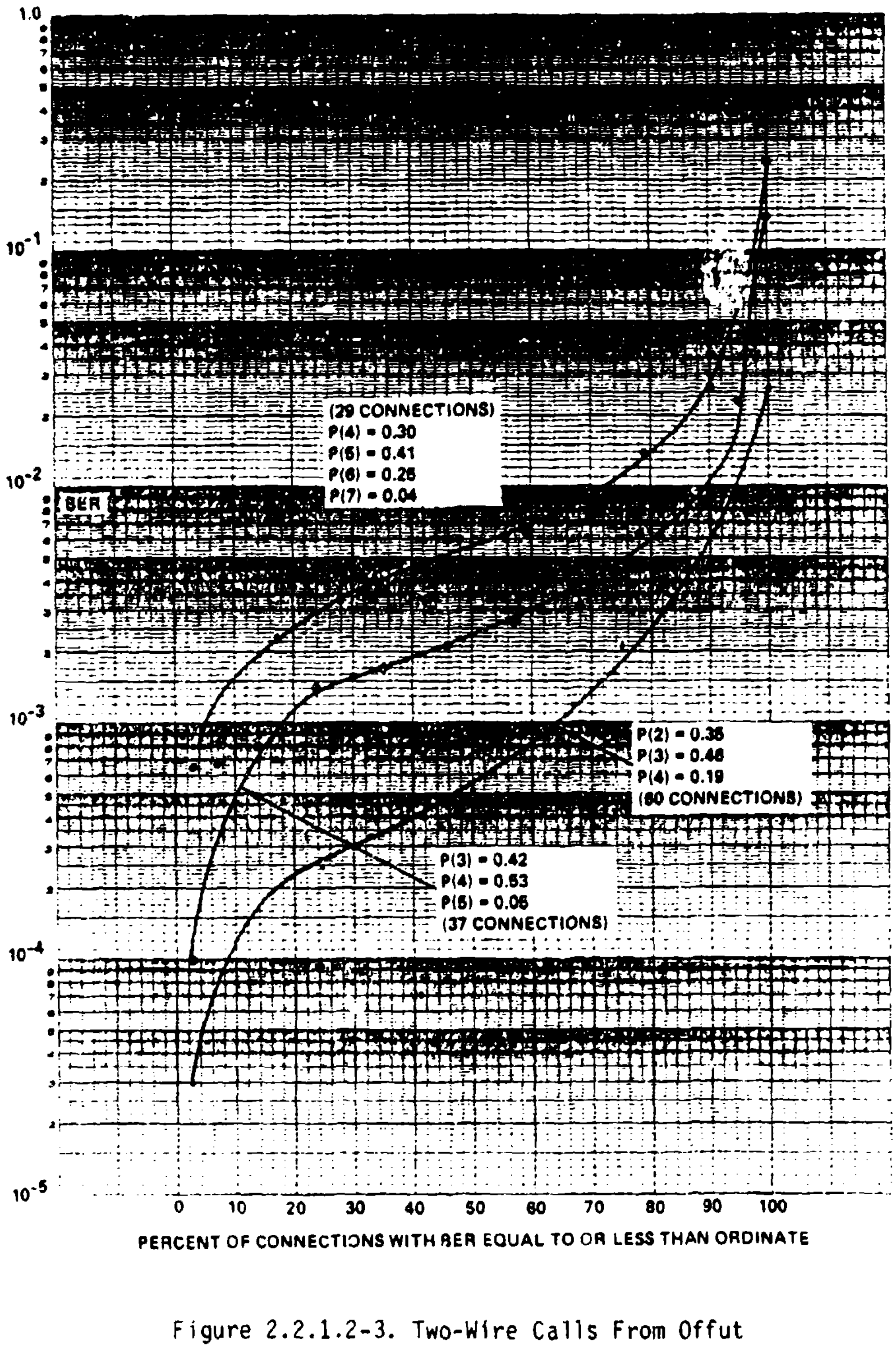


Figure 2.2.1.2-3. Two-Wire Calls From Offut

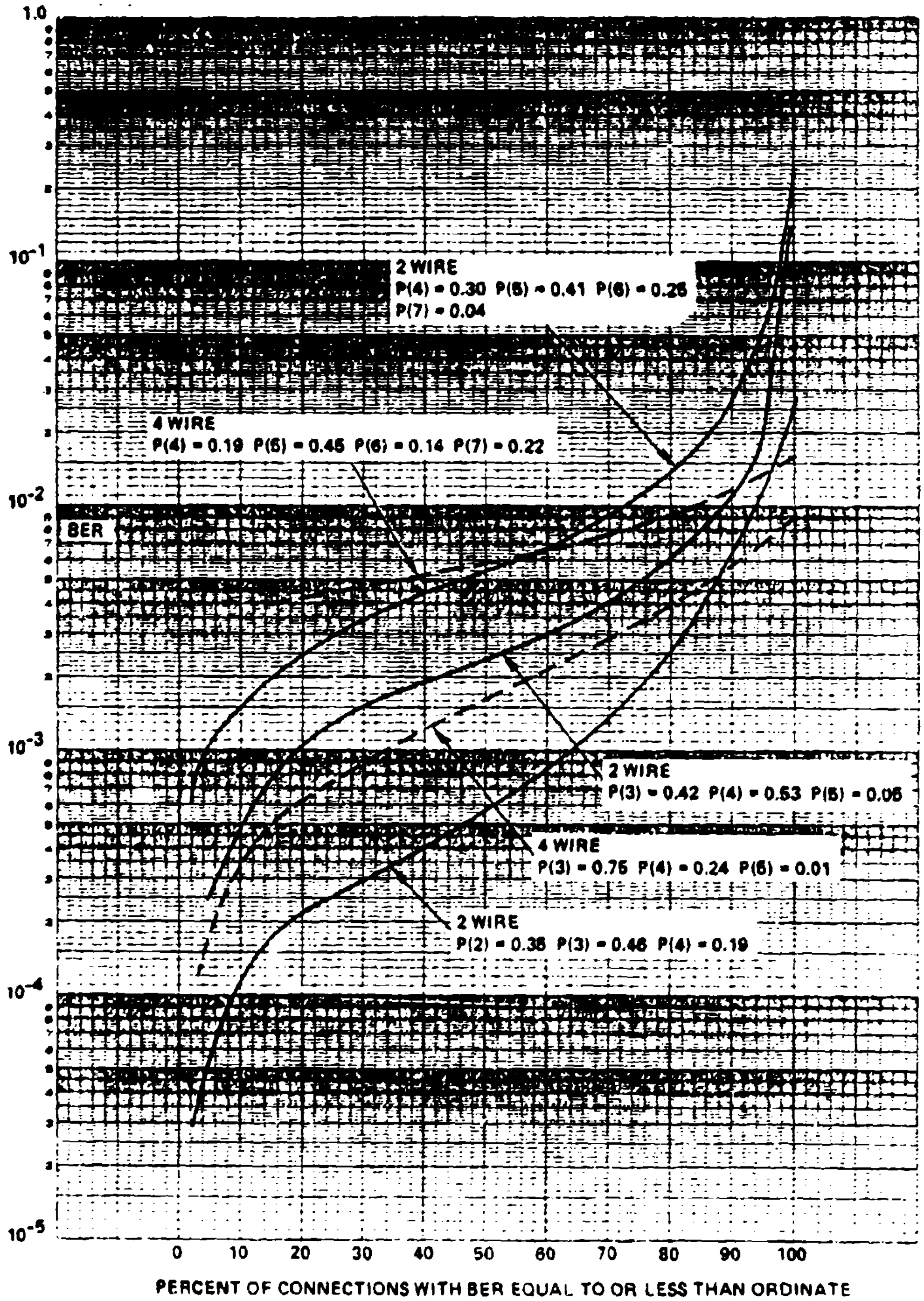


Figure 2.2.1.2-4. Comparison of Two- and Four-Wire Calls From Offut

2.2.1.3 Two-Wire Data From March

The access lines at March homed on the Julian, California, and Mojave, California switches. Some of the access lines use N2 carrier facilities whereas some are a combination of cable and LMX facilities. Unfortunately, it was not always possible to identify the type of access line particularly on incoming calls. Hence, most of the data presented here represents a combination of N2 and LMX calls.

Figure 2.2.1.3-1 shows the data obtained on access loops at March. The two curves show data obtained from loops that were known to involve N2 lines and loops where at least one of the access lines was unknown and the known lines were not N2.

Table 2.2.1.3 lists the calls placed from March to the Pentagon, to Melbourne and to Ft. Meade. In addition dial-through calls to distance switches and back to March are also listed. Figures 2.2.1.3-2, 2.2.1.3-3, and 2.2.1.3-4 show histograms of the BER values from March to Melbourne, the Pentagon and Ft. Meade respectively. Figure 2.2.1.3-5 shows calls from March to March via dial through. Figures 2.2.1.3-6, 2.2.1.3-7, and 2.2.1.3-8 show cumulative BER performance to these locations. The data to Ft. Meade always involved either N2, N1, T1/DID or T1/DIA lines at Ft. Meade. The calls involving N2 lines have been shown separately.

Figure 2.2.1.3-9 shows a comparison of the two- and four-wire data from March. The data from March to Ft. Meade is not included. Since most of the four-wire data from March involved calls to Melbourne, it is interesting to compare the Melbourne two-wire data with the four-wire data. As can be seen, the Melbourne two-wire performance appears to be somewhat better than the four-wire performance from March. The Pentagon two-wire

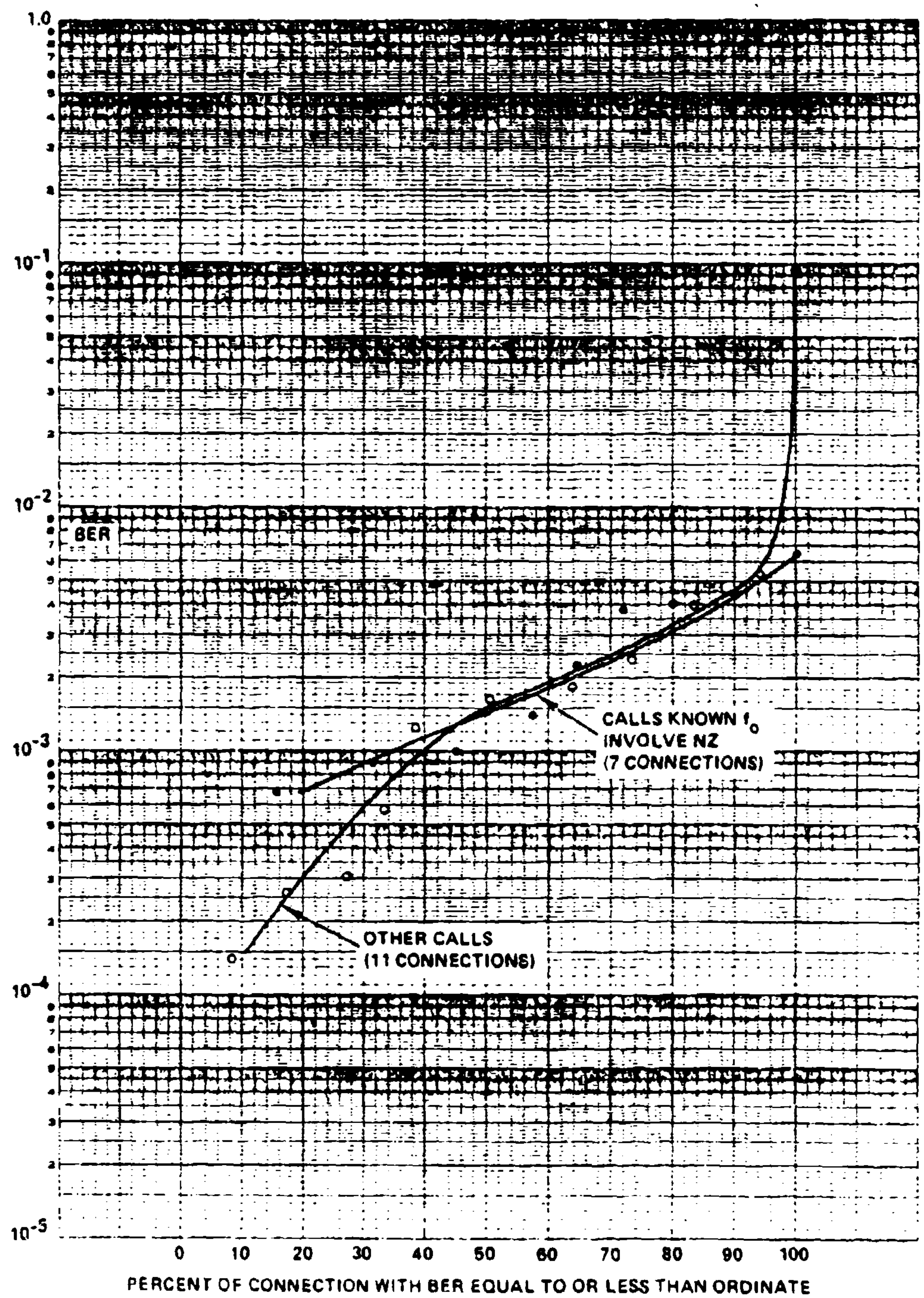


Figure 2.2.1.3-1. Two-Wire Access Calls From March

Table 2.2.1.3. Two-Wire Calls from March-Melbourne/Ft. Meade/ Pentagon/March

Normal Calls

MED BER		MED BER		MED BER	
March	MELB	March	Ft. Meade	March	Pentagon
2.6-3	-	8.8-2	7.3-3	3.6-3	2.1-3
3.6-3	-	1.1-1	7.6-3	5.9-3	3.9-3
4.9-3	1.0-3	6.7-3	6.1-3	3.2-3	1.3-3
3.8-3	6.3-4	3.6-3	3.7-3	3.1-3	1.0-3
5.3-3	1.2-3	1.6-2	1.2-2	1.4-2	7.4-4
2.2-3	2.0-2	-	1.0-2	5.0-3	7.7-4
3.2-3	3.3-4	2.7-2	1.6-2	4.4-3	1.2-3
1.1-3	2.1-3	6.3-3	9.7-3	7.8-3	1.2-3
1.7-3	1.1-2	7.2-3	4.6-3	8.2-3	1.6-3
9.6-4	2.8-3	6.4-2	7.1-2	-	3.4-3
1.1-3	1.8-4	3.9-2	5.1-2		
1.3-2	3.0-3				
2.5-3	7.5-3				

Dial Through

3-6 Switch DT (March-MELB)	March BER	MELB BER	P (3)	P (4)	P (5)	P (6)
X-SEG-POL	1.8-3	1.3-3	0.18	0.32	0.33	0.17
POL-SEG-X	2.9-3	1.7-3	0.18	0.43	0.32	0.07
MOJ-ARL-POL	1.2-2	3.8-4	0.24	0.58	0.18	0
MOJ-ARL-POL	6.8-3	5.5-4	0.24	0.58	0.18	0
X-SEG-POL	2.0-3	1.4-3	0.18	0.32	0.33	0.17
POL-SEG-X	1.3-3	4.0-3	0.18	0.43	0.32	0.07
POL-SEG-X	4.6-3	2.5-3	0.18	0.43	0.32	0.07

4-8 Switch DT (March-MELB)	March BER	MELB BER	P (4)	P (5)	P (5)	P (7)	P (8)
X-SEG-JAS-POL	9.6-3	6.3-3	0.11	0.32	0.36	0.18	0.03
POL-JAS-SEG-X	6.4-3	3.7-3	0.11	0.33	0.36	0.17	0.03
JUL-DRA-ARL-POL	1.6-2	5.2-3	0.30	0.51	0.18	0.01	0
X-SEG-JAS-POL	2.6-2	5.2-3	0.11	0.32	0.36	0.18	0.03
POL-JAS-SEG-X	1.8-2	7.8-3	0.11	0.33	0.36	0.17	0.03
POL-JAS-SEG-X	1.7-2	7.1-3	0.11	0.33	0.36	0.17	0.03

Table 2.2.1.3. Two-Wire Calls from March-Melbourne/Ft. Meade/ Pentagon/March (Continued)

5-9 Switch DT (March-MELB)	March BER	MELB BER	P (5)	P (6)	P (7)	P (8)	P (9)
X-SLO-SEG-JAS-POL	8.2-3	6.8-3	0.13	0.36	0.35	0.14	0.02
POL-JAS-SEG-SLO-X	6.8-3	4.7-3	0.13	0.36	0.35	0.14	0.02
MOJ-SLO-SEG-ARL-POL	3.4-2	-	0.19	0.42	0.30	0.08	0.01
MOJ-SLO-SEG-ARL-POL	2.2-2	1.8-2	0.19	0.42	0.30	0.08	0.01
X-SLO-SEG-JAS-POL	2.0-2	9.2-3	0.13	0.36	0.35	0.14	0.02
POL-SEG-JAS-X-X	2.0-2	9.3-3	0.23	0.46	0.26	0.05	0
POL-JAS-SEG-SLO-X	1.0-2	4.3-3	0.13	0.36	0.35	0.14	0.02

7-11 Switch DT (March-MELB)	March BER	MELB BER	P (7)	P (8)	P (9)	P (10)	P (11)
MOJ-SLO-SEG-DRA-POT-ARL-POL	7.3-2	3.6-2	0.15	0.38	0.36	0.10	0.01
POL-X-SLO-SEG-JAS-X-X	7.4-2	3.0-2	0.06	0.27	0.38	0.24	0.05

3-6 Switch DT (March-Pentagon)	March BER	Pentagon BER	P (3)	P (4)	P (5)	P (6)
X-SEG-X	2.9-2	1.8-2	0.20	0.44	0.31	0.05
X-SLO-X	1.5-2	7.1-3	0.18	0.49	0.33	0

4-8 Switch DT (March-Pent)	March BER	Pent BER	P (4)	P (5)	P (6)	P (7)	P (8)
X-SEG-SLO-X	8.8-3	6.7-3	0.11	0.23	0.37	0.27	0.15

5-9 Switch DT (March-Pent)	March BER	Pent BER	P (5)	P (6)	P (7)	P (8)	P (9)
X-JAS-SEG-SLO-X	1.9-2	2.2-2	0.14	0.37	0.34	0.13	0.02
X-POT-MOS-SEG-X	9.4-2	4.3-2	0.13	0.36	0.35	0.14	0.02
X-MOS-SEG-SLO-X	5.6-2	6.5-2	0.20	0.45	0.30	0.05	0

4-6 Switch DT (March-Ft. Meade)	March BER	Pent BER	P (4)	P (5)	P (6)
X-SLO-ARL-MON	1.1-1	3.2-2	0.22	0.52	0.28

5-8 Switch DT (March-Ft. Meade)	March BER	Pent BER	P (5)	P (6)	P (7)	P (8)
X-SLO-SEG-ARL-MON	1.1-1	9.3-2	0.21	0.47	0.28	0.04

2-3 Switch DT (March-March)	March BER	P (2)	P (3)
JUL-MOJ	1.8-3	0.50	0.50

Table 2.2.1.3. Two-Wire Calls from March-Melbourne/Ft. Meade/ Pentagon/March

Normal Calls

MED BER		MED BER		MED BER	
March -	MELB	March -	Ft. Meade	March -	Pentagon
2.6-3	-	8.8-2	7.3-3	3.6-3	2.1-3
3.6-3	-	1.1-1	7.6-3	5.9-3	3.9-3
4.9-3	1.0-3	6.7-3	6.1-3	3.2-3	1.3-3
3.8-3	6.3-4	3.6-3	3.7-3	3.1-3	1.0-3
5.3-3	1.2-3	1.6-2	1.2-2	1.4-2	7.4-4
2.2-3	2.0-2	-	1.0-2	5.0-3	7.7-4
3.2-3	3.3-4	2.7-2	1.6-2	4.4-3	1.2-3
1.1-3	2.1-3	6.3-3	9.7-3	7.8-3	1.2-3
1.7-3	1.1-2	7.2-3	4.6-3	8.2-3	1.6-3
9.6-4	2.8-3	6.4-2	7.1-2	-	3.4-3
1.1-3	1.8-4	3.9-2	5.1-2		
1.3-2	3.0-3				
2.5-3	7.5-3				

Dial Through

3-6 Switch DT (March-MELB)	March BER	MELB BER	P (3)	P (4)	P (5)	P (6)
X-SEG-POL	1.8-3	1.3-3	0.18	0.32	0.33	0.17
POL-SEG-X	2.9-3	1.7-3	0.18	0.43	0.32	0.07
MOJ-ARL-POL	1.2-2	3.8-4	0.24	0.58	0.18	0
MOJ-ARL-POL	6.8-3	5.5-4	0.24	0.58	0.18	0
X-SEG-POL	2.0-3	1.4-3	0.18	0.32	0.33	0.17
POL-SEG-X	1.3-3	4.0-3	0.18	0.43	0.32	0.07
POL-SEG-X	4.6-3	2.5-3	0.18	0.43	0.32	0.07

4-8 Switch DT (March-MELB)	March BER	MELB BER	P (4)	P (5)	P (5)	P (7)	P (8)
X-SEG-JAS-POL	9.6-3	6.3-3	0.11	0.32	0.36	0.18	0.03
POL-JAS-SEG-X	6.4-3	3.7-3	0.11	0.33	0.36	0.17	0.03
JUL-DRA-ARL-POL	1.6-2	5.2-3	0.30	0.51	0.18	0.01	0
X-SEG-JAS-POL	2.6-2	5.2-3	0.11	0.32	0.36	0.18	0.03
POL-JAS-SEG-X	1.8-2	7.8-3	0.11	0.33	0.36	0.17	0.03
POL-JAS-SEG-X	1.7-2	7.1-3	0.11	0.33	0.36	0.17	0.03

Table 2.2.1.3. Two-Wire Calls from March-Melbourne/Ft. Meade/ Pentagon/March (Continued)

5-9 Switch DT (March-MELB)	March BER	MELB BER	P (5)	P (6)	P (7)	P (8)	P (9)
X-SLO-SEG-JAS-POL	8.2-3	6.8-3	0.13	0.36	0.35	0.14	0.02
POL-JAS-SEG-SLO-X	6.8-3	4.7-3	0.13	0.36	0.35	0.14	0.02
MOJ-SLO-SEG-ARL-POL	3.4-2	-	0.19	0.42	0.30	0.08	0.01
MOJ-SLO-SEG-ARL-POL	2.2-2	1.8-2	0.19	0.42	0.30	0.08	0.01
X-SLO-SEG-JAS-POL	2.0-2	9.2-3	0.13	0.36	0.35	0.14	0.02
POL-SEG-JAS-X-X	2.0-2	9.3-3	0.23	0.46	0.26	0.05	0
POL-JAS-SEG-SLO-X	1.0-2	4.3-3	0.13	0.36	0.35	0.14	0.02

7-11 Switch DT (March-MELB)	March BER	MELB BER	P (7)	P (8)	P (9)	P (10)	P (11)
MOJ-SLO-SEG-DRA-POT-ARL-POL	7.3-2	3.6-2	0.15	0.38	0.36	0.10	0.01
POL-X-SLO-SEG-JAS-X-X	7.4-2	3.0-2	0.06	0.27	0.38	0.24	0.05

3-6 Switch DT (March-Pentagon)	March BER	Pentagon BER	P (3)	P (4)	P (5)	P (6)
X-SEG-X	2.9-2	1.8-2	0.20	0.44	0.31	0.05
X-SLO-X	1.5-2	7.1-3	0.18	0.49	0.33	0

4-8 Switch DT (March-Pent)	March BER	Pent BER	P (4)	P (5)	P (6)	P (7)	P (8)
X-SEG-SLO-X	8.8-3	6.7-3	0.11	0.23	0.37	0.27	0.15

5-9 Switch DT (March-Pent)	March BER	Pent BER	P (5)	P (6)	P (7)	P (8)	P (9)
X-JAS-SEG-SLO-X	1.9-2	2.2-2	0.14	0.37	0.34	0.13	0.02
X-POT-MOS-SEG-X	9.4-2	4.3-2	0.13	0.36	0.35	0.14	0.02
X-MOS-SEG-SLO-X	5.6-2	6.5-2	0.20	0.45	0.30	0.05	0

4-6 Switch DT (March-Ft. Meade)	March BER	Pent BER	P (4)	P (5)	P (6)
X-SLO-ARL-MON	1.1-1	3.2-2	0.22	0.52	0.28

5-8 Switch DT (March-Ft. Meade)	March BER	Pent BER	P (5)	P (6)	P (7)	P (8)
X-SLO-SEG-ARL-MON	1.1-1	9.3-2	0.21	0.47	0.28	0.04

2-3 Switch DT (March-March)	March BER	P (2)	P (3)
JUL-MOJ	1.8-3	0.50	0.50

Table 2.2.1.3. Two-Wire Calls from March-Melbourne/Ft. Meade/Pentagon/March (Continued)

3-5 Switch DT (March-March)	March BER	P (3)	P (4)	P (5)
MOJ-SLO-X	1.5-3	0.38	0.44	0.18
MOJ-SLO-X	4.4-3	0.38	0.44	0.18
MOJ-SLO-X	6.6-3	0.38	0.44	0.18
MOJ-SLO-X	2.4-3	0.38	0.44	0.18

4-7 Switch DT (March-March)	March BER	P (4)	P (5)	P (6)	P (7)
X-SLO-SEG-X	2.0-2	0.14	0.36	0.37	0.13

6-10 Switch DT (March-March)	March BER	P (6)	P (7)	P (8)	P (9)	P (10)
X-SLO-SEG-JAS-X-X	9.4-2	0.07	0.28	0.38	0.22	0.05
X-SLO-SEG-JAS-X-X	2.3-2	0.07	0.28	0.38	0.22	0.05

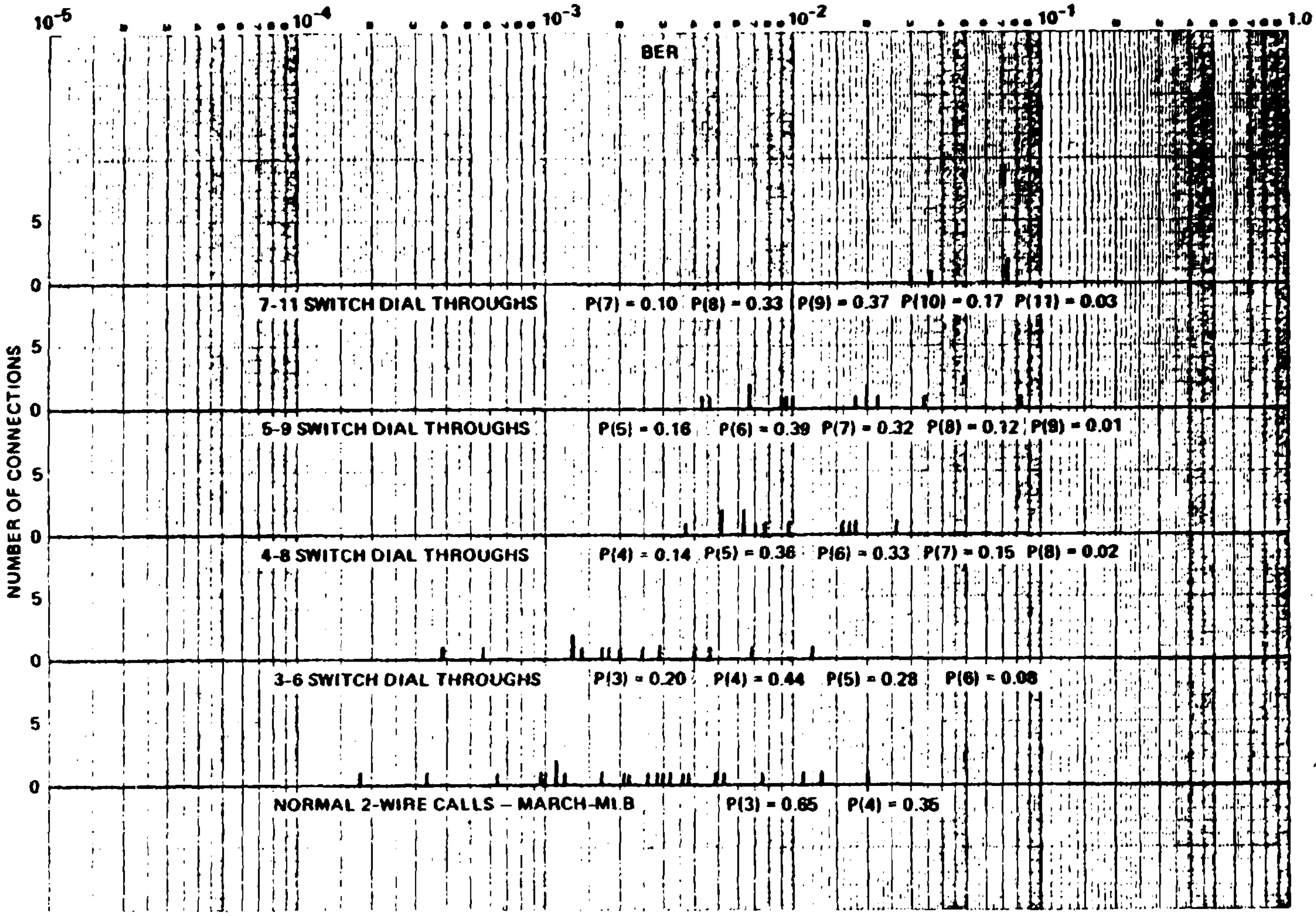


Figure 2.2.1.3-2. Two-Wire Calls From March to Melbourne (Histogram)

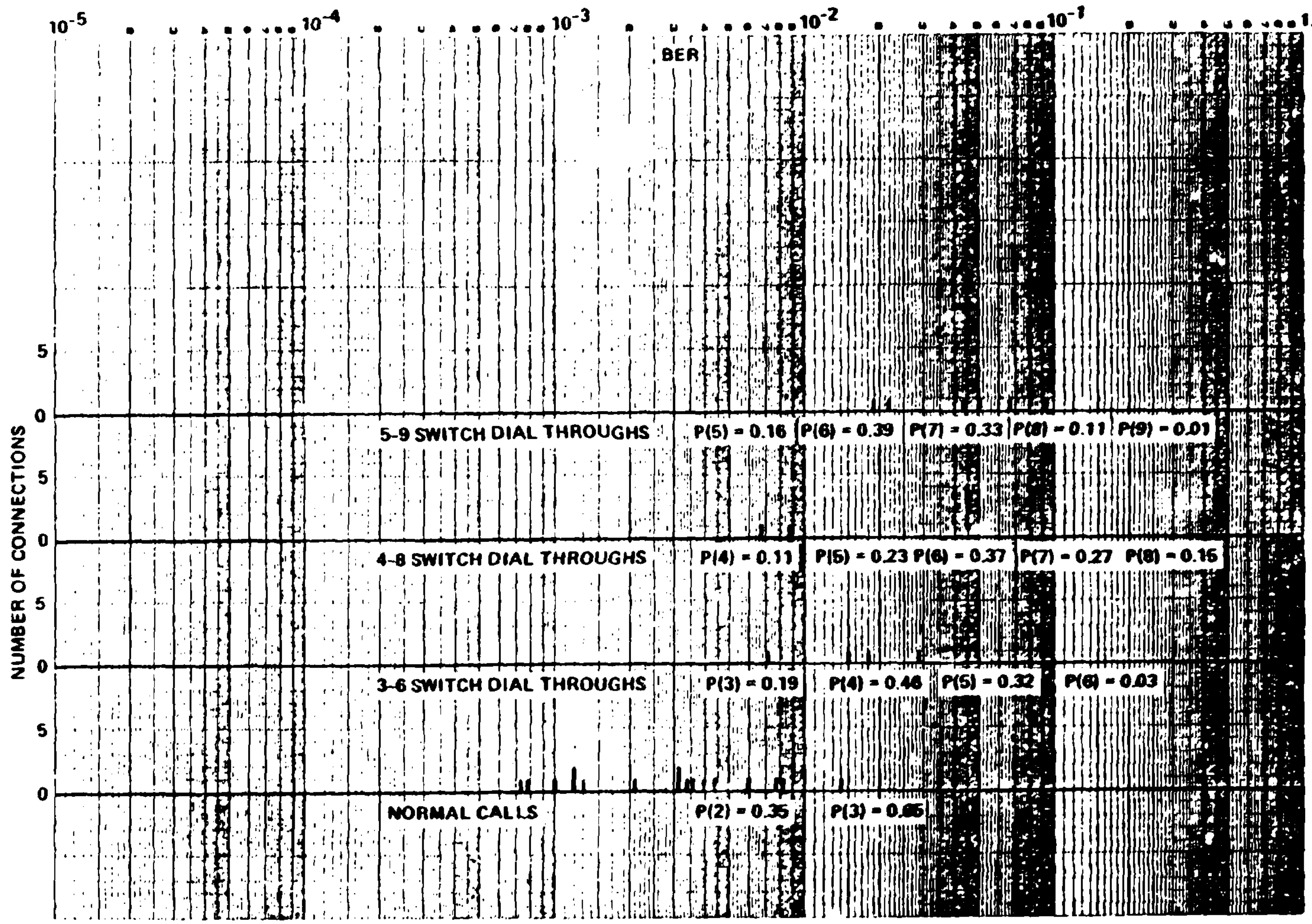


Figure 2.2.1.3-3. Two-Wire Calls From March to the Pentagon (Histogram)

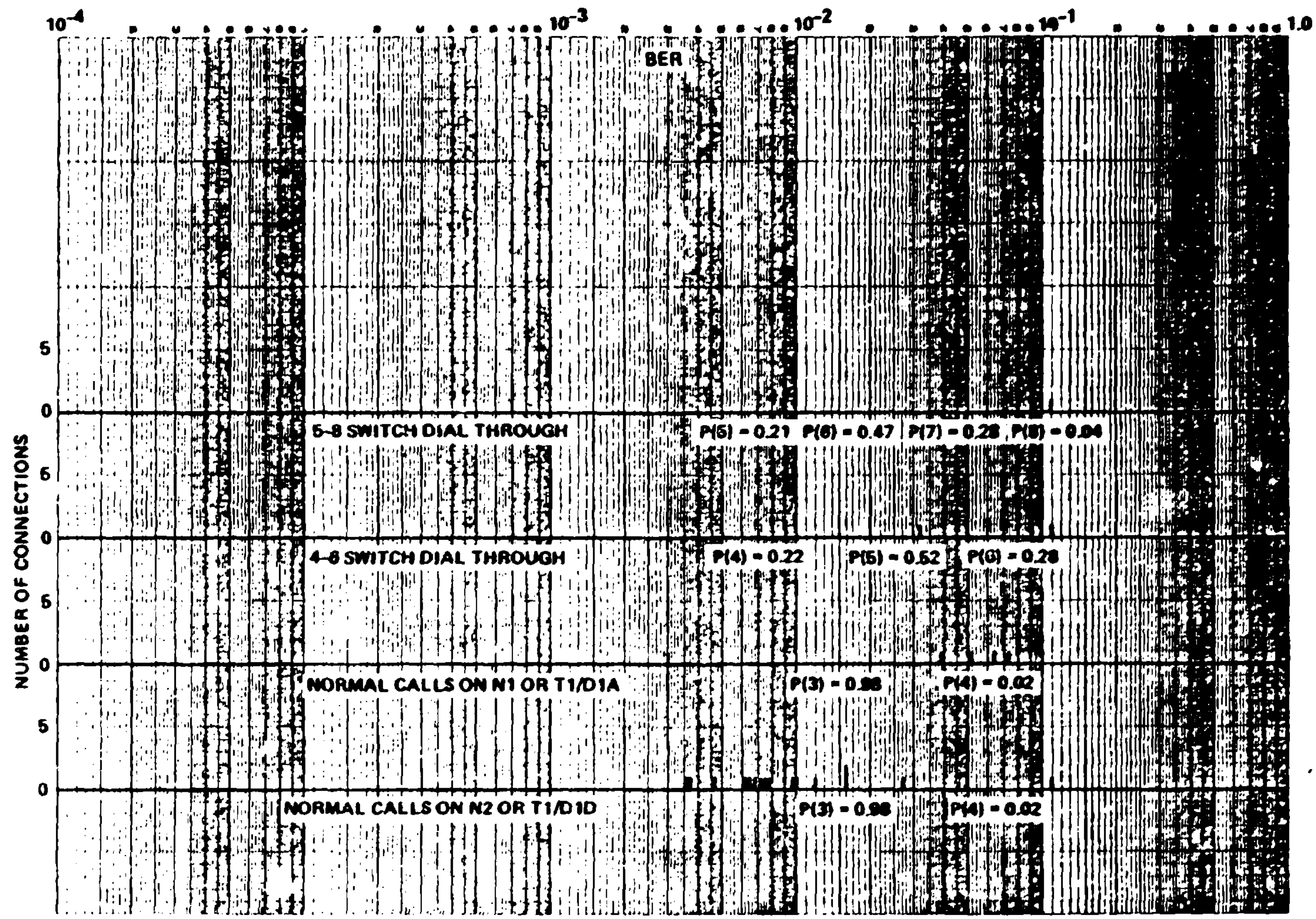


Figure 2.2.1.3-4. Two-Wire Calls From March to Ft. Meade (Histogram)

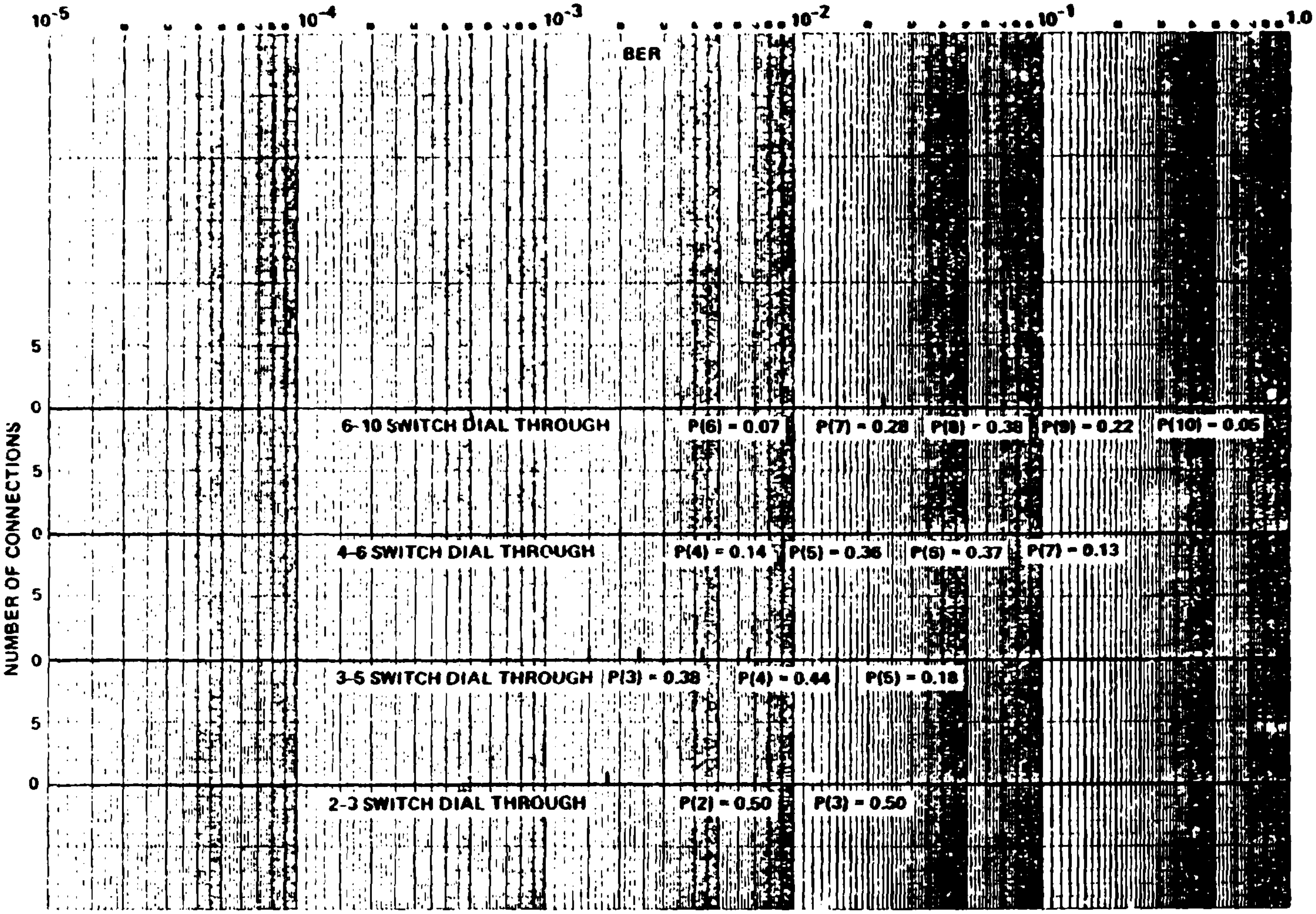


Figure 2.2.1.3-5. Two-Wire Dial Through Calls From March to March

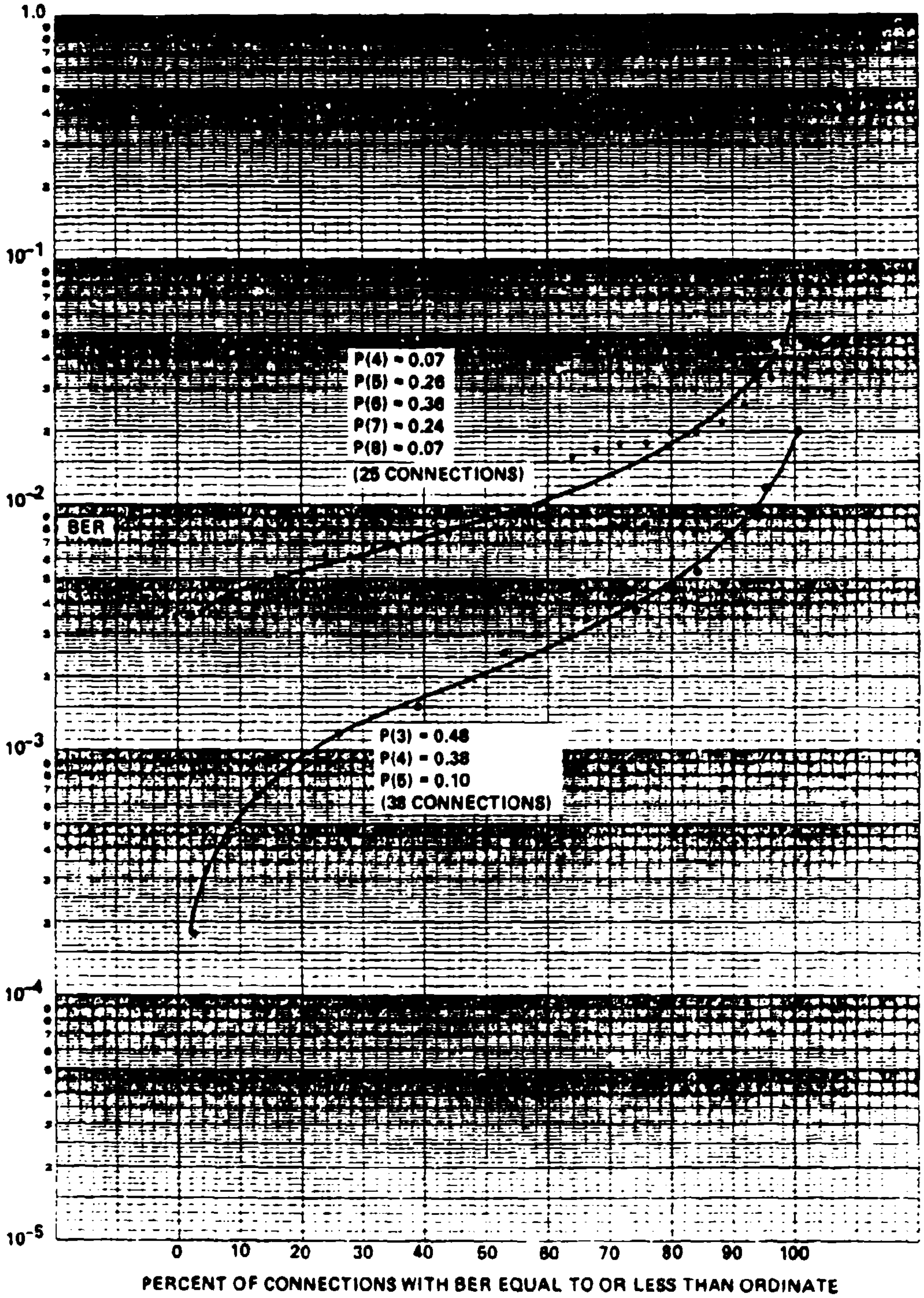


Figure 2.2.1.3-6. Two-Wire Calls From March to Melbourne

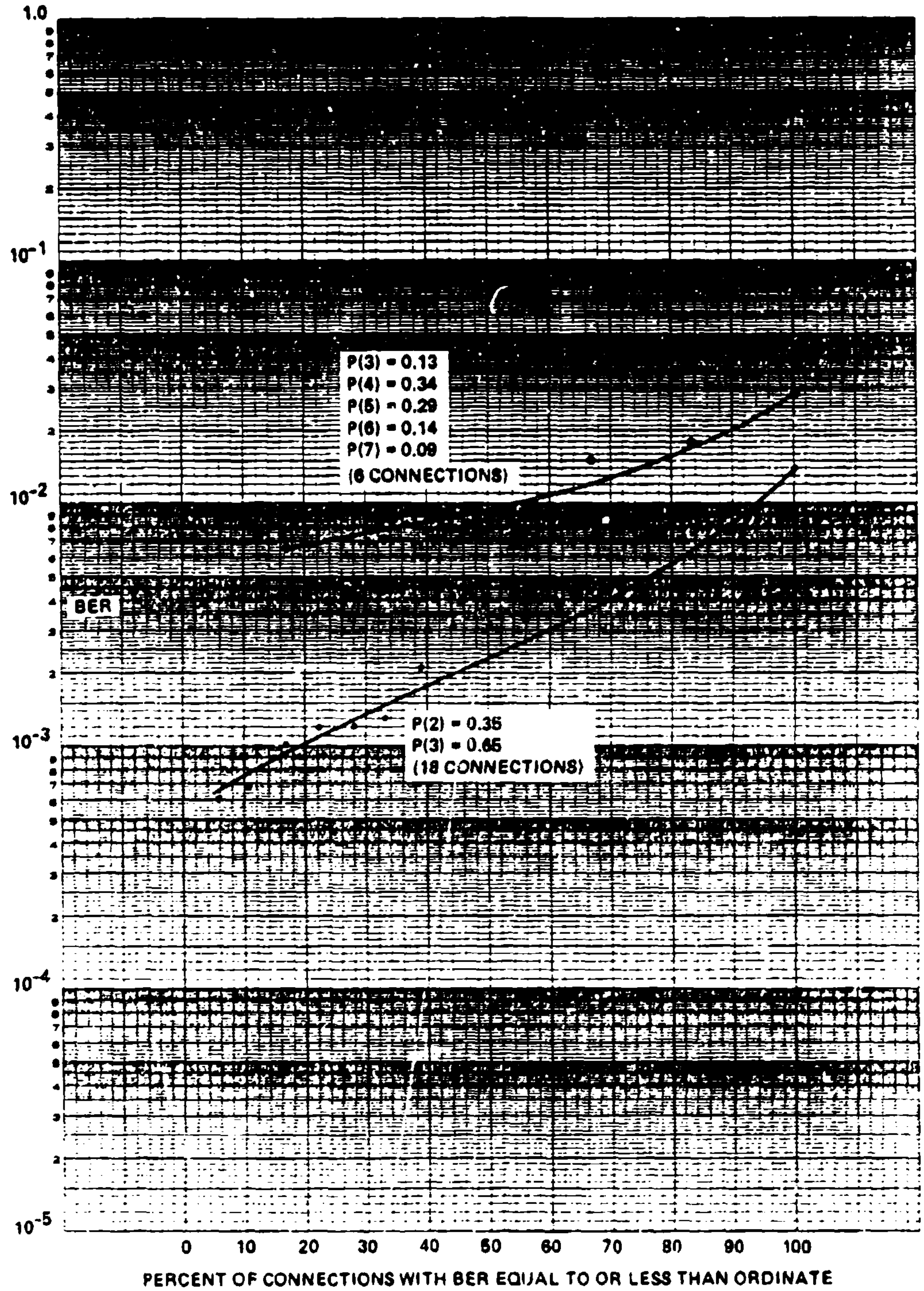


Figure 2.2.1.3-7. Two-Wire Calls From March to Pentagon

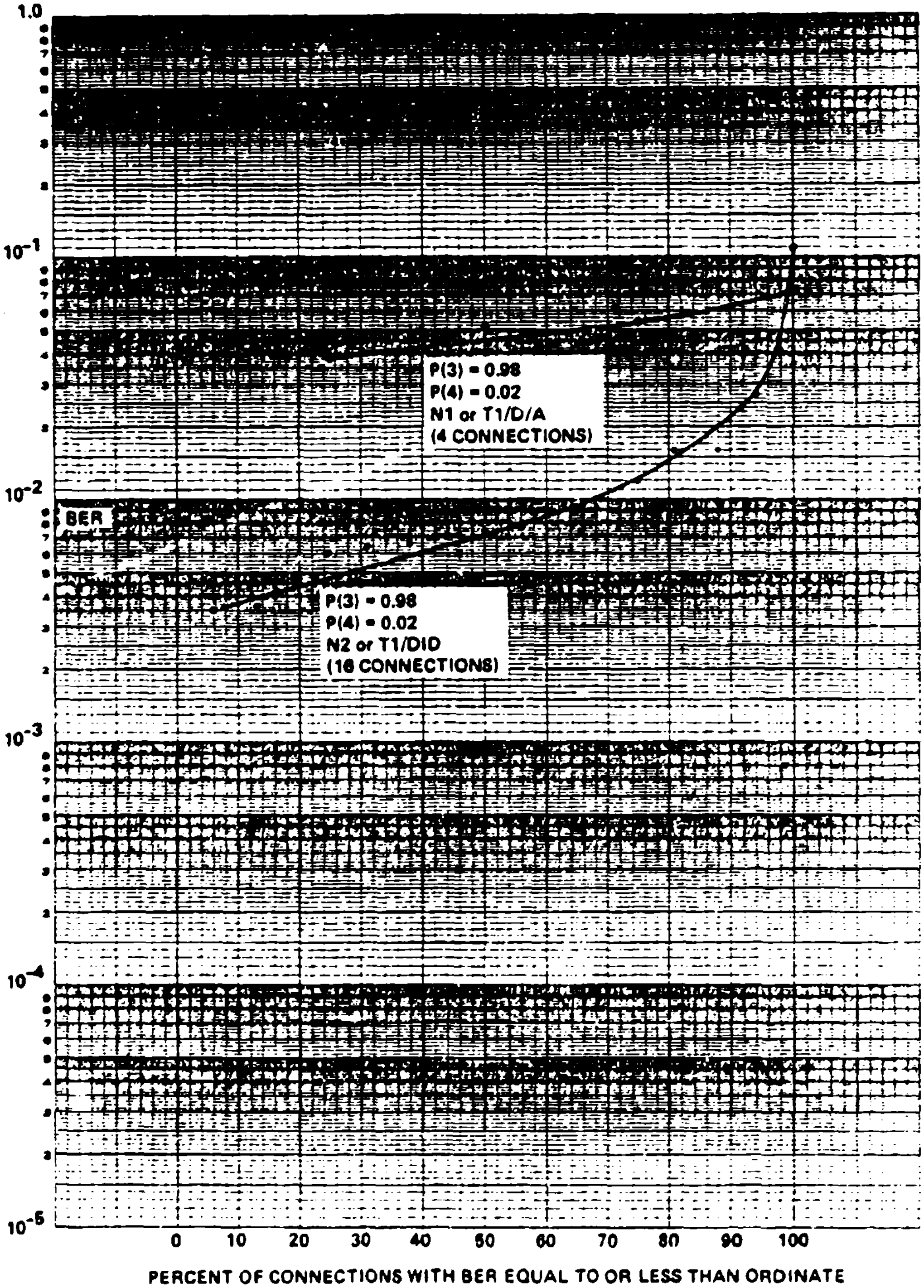


Figure 2.2.1.3-8. Calls From March to Ft. Meade

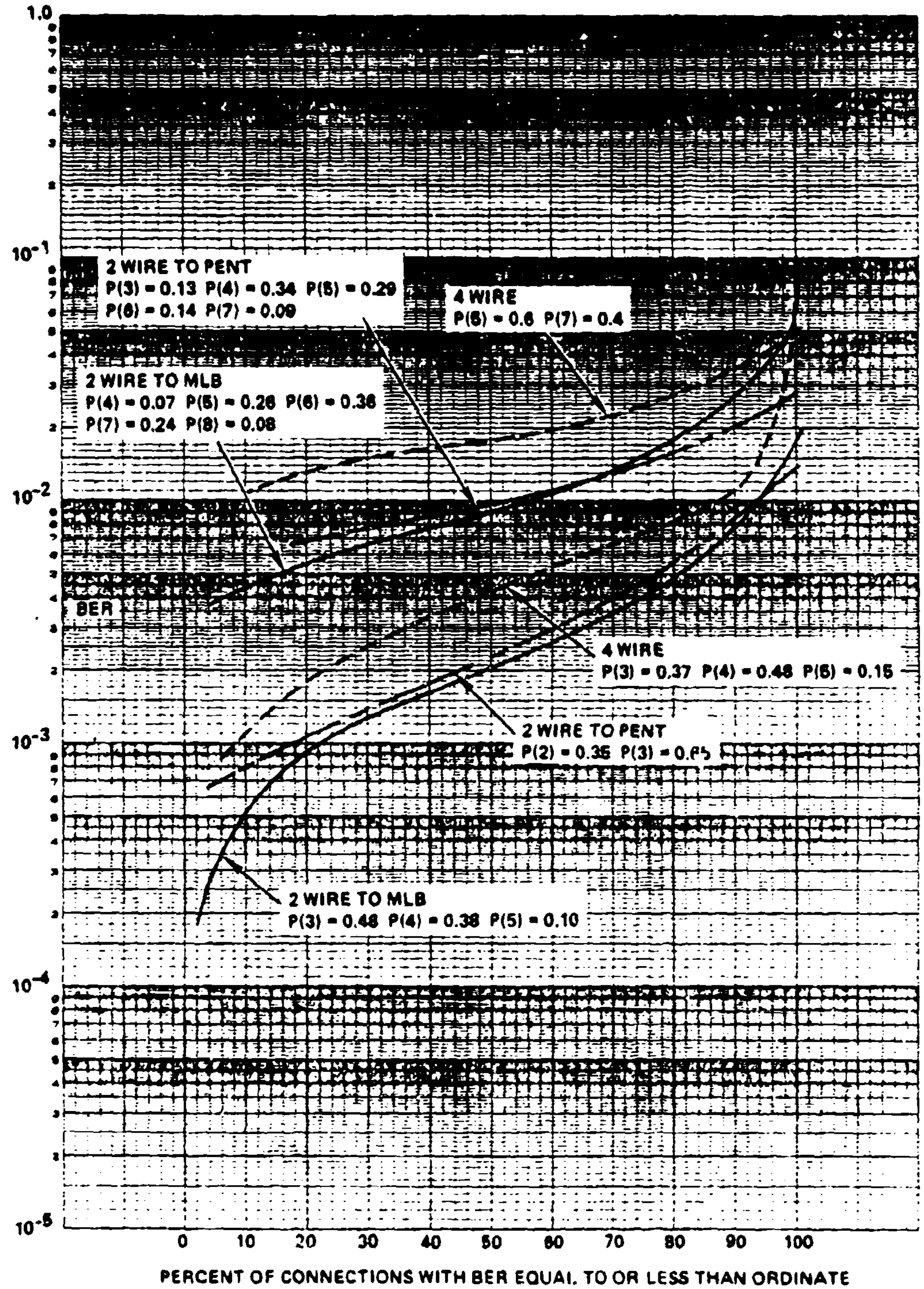


Figure 2.2.1.3-9. Comparison of Four- and Two-Wire Calls From March

performance from March appears to be in the same ball park as the four-wire performance from March.

2.2.1.4 Two-Wire Data From the Pentagon

The two-wire data with long distance calls involving the Pentagon has alreeady been presented in the preceding paragraphs. A number of two-wire access line calls, however, were placed which have not been presented. Figure 2.2.1.4 shows the cumulative BER performance on two-wire access loops placed from the Pentagon. Since the specific access lines were not identified the calls could have gone to either the Arlington or Drainsville switch or both. There is also some chance that a call involving both switches could have been diverted to even more switches but the probability of this event is likely to be small. (The blockage probability between Arlington and Drainsville during busy hours is only 0.075.)

In addition, Figure 2.2.1.4 shows cumulative BER performance on loops through the Washington tactical switchboard.

2.2.1.5 Two-Wire Data From Ft. Meade

As was the case in the Pentagon two-wire data, the long distance data concerning Ft. Meade calls has already been presented. However, data on some local two-wire access line calls have not.

Table 2.2.1.5 lists results from access loops involving N1 and T1 access lines along with the specific combination of carrier system indicated. The type of bank associated with T1 system indicated is probably D1A or D1B. It appears certain that modem performance is unacceptable when

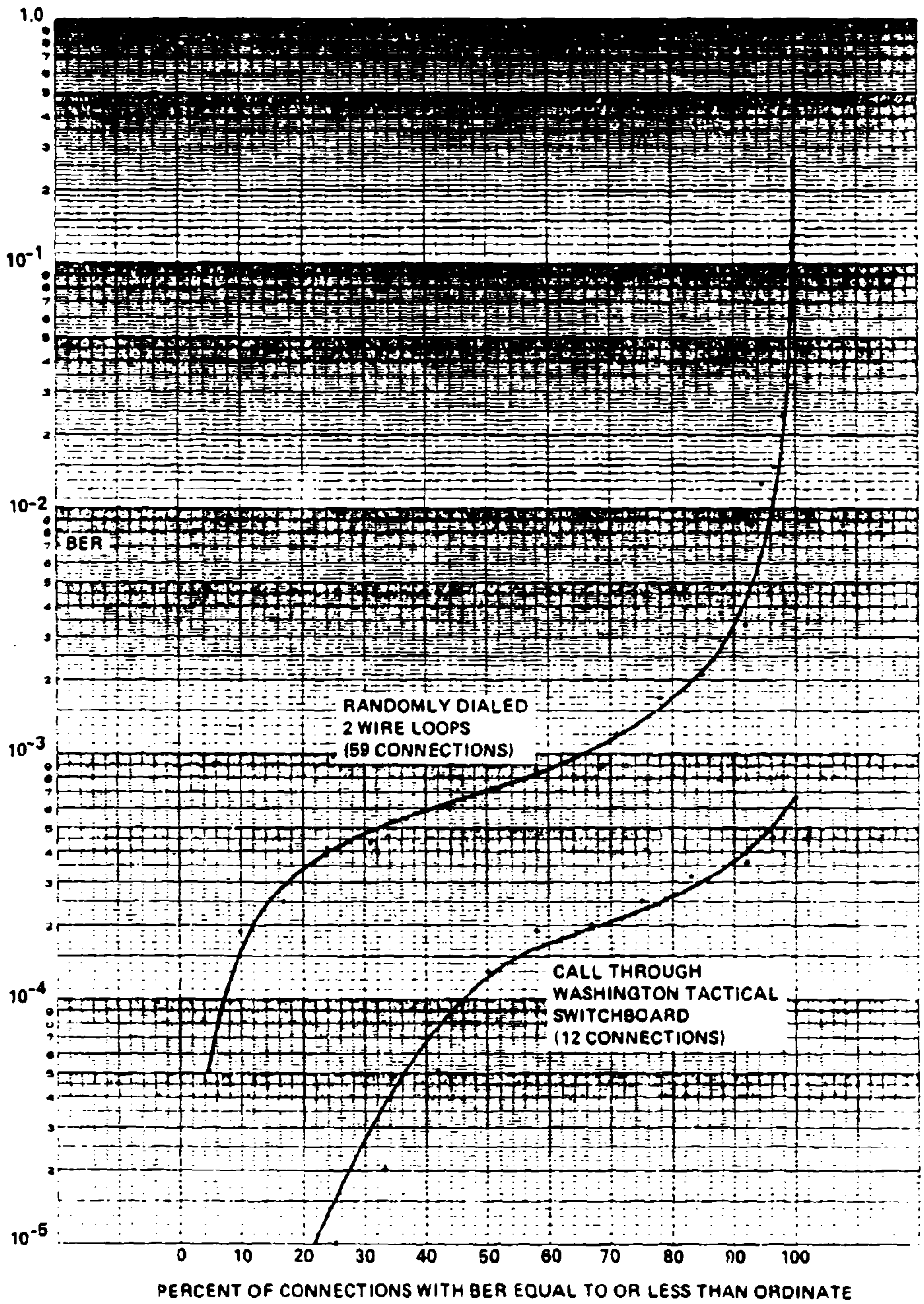


Figure 2.2.1.4. Two-Wire Loops From Pentagon

Table 2.2.1.5. Access Loops From Ft. Meade

Type of Access Lines			BER
N1	T1	2.9-2	2.3-2
W1	T1	9.2-3	1.2-2
T1	T1	4.1-3	2.3-2
N1	T1	2.3-2	3.6-2
N2	N1	1.7-1	9.4-3
N1	T1	1.7-2	2.0-1
N1	N1	6.0-2	2.0-1
N1	T1/DIA	1.0-1	4.8-2
T1	N1	1.3-2	4.9-2
N1	T1	7.6-4	2.1-4
N1	N1	6.0-2	2.4-1
T1/DIA	N1	7.7-2	6.2-2
N1	N1	4.9-2	1.8-2
N1	N1	5.2-2	5.0-2
N1	N1	5.0-2	5.3-2
N2	N2	2.2-4	9.0-5
N1	N1	3.1-2	5.3-2
T1/DIA	T1/DID	1.8-4	-

these types of facilities are involved. In addition to the loops on N1 and T1/DIA or DIB two loops involving N2 and T1/DID are listed. The error rates on these loops are relatively acceptable.

2.2.1.6 Two-Wire Calls Taken During the Site Survey

Table 2.2.1.6 lists the results of the 9 two-wire calls taken during the Phase I. The number of calls involved were too small to draw any conclusions from them. It is of interest that two of the five calls from March were taken from an office that was located approximately 9 miles from the PBX at March. This extra run didn't appear to provide any additional degradation.

Table 2.2.1.6. Two-Wire Call During Phase I

From	To	BER		Comments
Ft. Meade	Melbourne	2.0E-1	-	T1/DIA
Ft. Meade	Melbourne	1.3E-1	-	T1/DIA
McChord	Melbourne	1.4E-3	1.7E-2	-
March	Melbourne	3.0E-3	9.9E-3	9 miles to PBX
March	Melbourne	6.0E-3	4.3E-3	9 miles to PBX
March	Melbourne	3.7E-3	3.0E-3	9 miles to PBX
March	Melbourne	2.8E-3	1.2E-4	-
March	Melbourne	6.8E-3	3.5E-3	-
MacDill	Melbourne	1.7E-3	2.5E-4	-

2.2.2 Commercial Calls

There were 36 commercial calls placed during both Phase I and Phase II. During Phase I these calls were placed from both on-base and off-base sites to Melbourne. During Phase II these calls were placed from MacDill, Offut or March to either the Pentagon or Ft. Meade. It is likely that some of the poor performance observed during Phase I was due to the impedance mismatch in the modem and may be alleviated by the better matching network. Other than this effect, the general conclusion that can be drawn is felt to be similar to that which can be drawn from the Autovon tests. That is, the performance of the modem over the DDD network is acceptable when good access lines are available and unacceptable otherwise.

Table 2.2.2-1 lists the results on DDD calls placed during Phase I. Table 2.2.2-2 lists the results on DDD calls taken during Phase II.

2.2.3 Results at 8 kb/s and 9.6 kb/s Rates

As previously mentioned, during Phase II when 16 kb/s BER values exceeded 1 percent, BER values were also obtained at 8 kb/s and at 9.6 kb/s. In general, the error rates at these reduced rates were quite good even in cases where the 16 kb/s BER values were poor. The 8 and 9.6 kb/s BER values on all calls on which they were recorded are listed in Appendix C. However, it is interesting to observe tabulations of these results, in specific types of calls that caused problems to the 16 kb/s modem. Table 2.2.3-1 shows 16, 9.6, and 8 kb/s on commercial calls from MacDill. Table 2.2.3-2 shows results on the poor access loops at Ft. Meade. Table 2.2.3-3 lists results on calls in which three intervening switches were dialed. It should be noted that most of these calls were probably greater than five switch calls and several were a minimum of seven switch calls.

Table 2.2.2-1. Results of Commercial Calls During Phase I

From	To	BER Other	BER MELB	Comments
Ft. Meade, MD	Melbourne	6.0E-3	2.2E-3	From F Annex
Ft. Meade, MD	Melbourne	3.0E-2	1.6E-2	From F Annex
Ft. Meade, MD	Melbourne	2.3E-3	-	From Main Bldg. (Balt. Exch)
Ft. Meade, MD	Melbourne	2.1E-3	-	From Main Bldg. (Balt. Exch)
Laurel, MD	Melbourne	8.9E-2	-	Probably T1/DIA
Laurel, MD	Melbourne	1.1E-2	-	Probably T1/DIA
Laurel, MD	Melbourne	7.3E-2	-	Probably T1/DIA
Offut, NE	Melbourne	1.9E-1	-	At PBX
Cheyenne Mt, CO	Melbourne	2.4E-2	2.2E-2	-
Cheyenne Mt, CO	Melbourne	3.0E-1	2.8E-2	-
Tacoma, WA	Melbourne	8.0E-2	1.2E-2	-
Tacoma, WA	Melbourne	5.6E-2	8.0E-3	-
Tacoma, WA	Melbourne	4.9E-2	-	-
Tacoma, WA	Melbourne	3.8E-2	1.6E-3	-
Pt.Angeles, WA	Melbourne	1.5E-2	6.0E-3	-
Pt.Angeles, WA	Melbourne	1.0E-3	1.2E-4	-
Pt.Angeles, WA	Melbourne	7.2E-4	3.8E-4	-
Pt.Angeles, WA	Melbourne	6.5E-4	2.5E-4	-
McChord, WA	Melbourne	8.0E-2	5.5E-2	-
Santa Maria, CA	Melbourne	1.8E-3	2.5E-4	-
Santa Maria, CA	Melbourne	1.0E-2	6.2E-5	-
Santa Maria, CA	Melbourne	5.2E-3	-	-
Vandenberg, CA	Melbourne	2.4E-1	-	-
March, CA	Melbourne	3.1E-2	5.2E-3	Through 9 miles to PBX
March, CA	Melbourne	9.2E-3	1.2E-2	Through 9 miles to PBX
March, CA	Melbourne	7.5E-3	-	Through 9 miles to PBX
March, CA	Melbourne	2.1E-2	2.9E-2	Through 9 miles to PBX
Riverside, CA	Melbourne	1.1E-1	-	-
Riverside, CA	Melbourne	4.7E-2	2.8E-2	-
Riverside, CA	Melbourne	1.0E-1	4.2E-3	-
March, CA	Melbourne	4.6E-2	3.5E-3	-
Tampa, FL	Melbourne	3.2E-3	0	-
Tampa, FL	Melbourne	5.4E-4	0	-
Tampa, FL	Melbourne	4.7E-4	1.9E-3	-
MacDill, FL	Melbourne	2.8E-4	5.0E-4	-
MacDill, FL	Melbourne	5.1E-3	6.2E-4	-

Table 2.2.2-2. Results of Commercial Calls During Phase II

MacDill - Pentagon	
1.4E-1	9.5E-4
2.7E-3	2.0E-4
1.0E-1	-
2.2E-1	9.0E-5
1.7E-1	2.1E-4

March - Ft. Meade	
2.6E-2	9.6E-3
1.0E-2	4.8E-2
1.3E-2	3.7E-2
3.9E-2	1.2E-2

Offut - Pentagon	
5.4E-4	4.2E-4
3.2E-4	2.3E-4
1.1E-4	2.8E-4
8.0E-4	1.1E-3
3.0E-4	2.6E-4
3.3E-4	4.1E-4
7.3E-4	6.3E-4
4.8E-4	3.9E-4
1.0E-3	5.8E-4
5.0E-3	4.1E-3
5.8E-2	1.5E-2
4.4E-2	4.1E-3
7.5E-4	2.6E-4
1.3E-4	9.0E-5
5.0E-4	6.7E-4
3.0E-4	0
1.0E-3	1.7E-3

March - Pentagon	
2.9E-3	4.3E-4
1.4E-3	8.4E-4
2.0E-3	5.4E-4
2.4E-3	7.4E-4
4.2E-4	3.8E-4
3.8E-4	3.8E-4
2.3E-3	1.4E-3
4.6E-4	7.4E-4
8.9E-4	1.8E-3
1.0E-1	1.0E-3

Table 2.2.3-1. Commercial Calls From MacDill, FL to Pentagon
Comparison of 16, 8 and 9.6 kb/s

BER at MacDill			BER at Pentagon		
16 kb/s	8 kb/s	9.6 kb/s	16 kb/s	8 kb/s	9.6 kb/s
1.4^{-1}	1.0^{-4}	0	9.5^{-4}	*	*
2.7^{-3}	*	*	2.0^{-4}	*	*
1.0^{-1}	0	-	-	-	-
2.2^{-1}	1.2^{-4}	0	9.0^{-5}	*	*
1.7^{-1}	1.0^{-5}	0	2.1^{-4}	*	*

* Presumed to be better than 10^{-5}

Table 2.2.3-2. Two-Wire Access Loops at Ft. Meade on NI and T1-DIA or DIB Lines (Comparison of 16, 8 and 9.6 kb/s)

BER In One Direction			BER In Other Direction		
16 kb/s	8 kb/s	9.6 kb/s	16 kb/s	8 kb/s	9.6 kb/s
2.3^{-2}	-	-	2.3^{-2}	-	-
1.2^{-2}	-	-	1.2^{-2}	-	-
1.4^{-3}	*	*	7.1^{-4}	*	*
4.1^{-3}	*	*	2.3^{-2}	-	-
2.3^{-2}	-	-	3.6^{-2}	-	-
1.7^{-1}	-	-	9.4^{-3}	*	*
1.7^{-2}	-	-	2.0^{-1}	-	-
6.0^{-2}	-	-	2.0^{-1}	-	-
1.0^{-1}	-	-	4.8^{-2}	2.0^{-5}	3.1^{-5}
1.3^{-2}	0	0	4.9^{-2}	1.0^{-5}	4.2^{-5}
7.6^{-4}	*	*	2.1^{-4}	*	*
6.0^{-2}	3.0^{-5}	2.2^{-4}	2.4^{-1}	6.5^{-2}	6.9^{-2} (SF Filter)
7.7^{-2}	6.7^{-4}	1.7^{-4}	6.2^{-2}	4.0^{-4}	2.1^{-5}
4.9^{-2}	0	1.2^{-4}	1.8^{-2}	0	0
5.2^{-2}	0	9.4^{-5}	5.0^{-2}	0	5.2^{-5}
5.0^{-2}	1.0^{-5}	-	5.3^{-2}	-	-
3.1^{-2}	1.1^{-4}	0	5.3^{-2}	5.0^{-5}	2.3^{-4}

* Presumed to be better than 10^{-5}

Table 2.2.3-3. 5-10 Switch Dial Through Calls

	BER at McDill/ Offut/March			BER at PENT/MELB/FT.M		
	16	8	9.6	16	8	9.6
MCD-JAS-NOR-MOS-PENT	3.6-2	-	1.1-4	2.6-2	-	-
MCD-JAS-NOR-MOS-PENT	1.3-1	8.0-5	2.5-4	3.8-2	0	4.2-5
MCD-SEQ-SLO-NOR-PENT	1.8-1	2.9-3	1.6-1	7.5-2	0	1.5-2
MCD-SEQ-JAS-NOR-PENT (4w)	4.4-2	0	8.3-5	6.2-2	2.5-5	1.0-5
PENT-JAS-NOR-YAK-Offut	1.4-1	1.2-4	4.9-2	7.1-2	1.4-4	2.4-3
PENT-POT-MOS-NOR-Offut	3.6-2	2.6-4	5.0-3	4.8-2	0	9.4-5
PENT-POT-MOS-NOR-Offut	2.5-2	0	4.1-4	2.2-2	0	0
Offut-NOR-MOS-POT-PENT (4w)	7.6-2	1.0-5	0	1.3-2	1.0-5	0
PENT-POT-MOS-NOR-Offut (4w)	-	-	-	2.1-2	-	-
MELB-JAS-SEQ-SLO-March	6.8-3	-	-	4.7-3	-	-
March-SLO-SEQ-ARL-MELB	3.4-2	-	-	-	-	-
March-SLO-SEQ-ARL-MELB	2.2-2	1.0-3	-	1.8-2	-	-
March-SLO-SEQ-JAS-MELB	2.0-2	-	-	9.2-3	-	-
MELB-SLO-SEQ-JAS-March	7.4-2	-	-	3.0-2	-	-
MELB-JAS-SEQ-JAS-March	1.0-2	-	-	4.3-3	-	-
March-SLO-SEQ-JAS-MELB	9.4-2	2.6-4	1.7-2	-	-	-
March-SLO-SEQ-JAS-MELB	2.3-2	0	3.5-5	-	-	-
March-SLO-SEQ-ARL-FT.M	-	-	-	9.3-2	0	3.1-5
March-SLO-SEQ-ARL-FT.M	1.1-1	4.2-4	2.6-4	-	-	-
PENT-JAS-SEQ-SLO-March	1.9-2	2.3-4	4.2-5	2.2-2	0	0
PENT-POT-MOS-SEQ-March	9.4-2	0	3.6-3	4.3-2	5.0-5	0
PENT-POT-MOS-SEQ-March	5.0-2	4.3-4	0	6.5-2	5.0-5	2.5-4

2.3 Results From NSA Simulator (Phase III)

The third phase of the program was to run tests on the NSA simulator. Several different sets of parameters were used for the tests. The first set was those supplied by NSA to represent poor and median voice and data grade lines for CONUS and European lines. The second set was identical to the first set with the CONUS harmonic distortion reduced to values equivalent to those previously measured on CONUS loop tests from Melbourne. The phase jitter on the European simulation was also reduced to correspond to that measured on the European Autovon lines during the previous 16 kb/s test program. The third set of data was identical to the second set except that the harmonic distortion for the CONUS data was reduced by 3 dB to simulate one-way calls rather than loops. Values of BER were measured for both 16 kb/s and 8 kb/s rates. Table 2.3 lists the results of these tests along with the parameters measured on the Halcyon line tester for each condition.

The data obtained is of interest but serves more to assess the realism of the simulator parameters than evaluate the modem since modem operation on the network, of course, is the ultimate performance measure. It is interesting to note that the European data, when the phase jitter is reduced to that observed in Europe, is considerably better than that actually obtained during the European tests, since the simulator did not have the capability to simulate fades caused by tropo-links which were the dominant error causing disturbance during the European tests. The results, however, are reasonably close to measured results in Europe on lines not involving fades.

Harmonic Distortion: The Halcyon measures the 2nd order nonlinear components B-A and A+B as well as 3rd Order 2B-A. The NSA Simulator is programmed to provide 2nd harmonic (2A) and 3rd (2B). There is no clear relationship between what is inputted into the NSA Simulator and that which is obtained in the field.

Table 2.3. Simulator Test Results

Case 1	16 kb/s	8 kb/s	S/N	2nd HD	3rd HD	Phase J.H.^{0}	Frequency Offset
CONUS Poor Voice	3.0E-1	1.7E-1	25	-20	-41	15	1
CONUS Poor Data	1.0E-1	2.0E-3	25	-20	-40	15	1
CONUS Median Voice	5.4E-2	3.3E-4	29	-25	-44	12	0
CONUS Median Data	4.8E-3	0	32	-27	-44	11.5	-
European Poor Voice	1.7E-2	2.6E-4	28	-36	∞	34	7
European Poor Data	6.6E-3	3.0E-5	28	-36	-45	36	6
European Median Voice	1 1E-3	3.0E-5	31	-42	-51	26	3.5
European Median Data	1.4E-4	0	33	-45	-61	18	3.5
Case 2							
CONUS Poor Voice	2.5E-1	8.2E-2		-27	-44		
CONUS Poor Data	1.2E-2	5.0E-5		-27	-44		
CONUS Median Voice	1.6E-2	0		-30	-49		
CONUS Median Data	8.4E-4	0		-32	-48		
European Poor Voice	1.2E-3	1.5E-4				12	
European Poor Data	5.7E-4	3.0E-5				12	
European Median Voice	1.0E-4	1.0E-5				6	
European Median Data	8.0E-5	0				6	

Table 2.3. Simulator Test Results (Continued)

Case 3	16 kb/s	8 kb/s	S/N	2nd HD	3rd HD	Phase J.H.°	Frequency Offset
CONUS Poor Voice	2.0E-1	6.6E-2		-30	-47		
CONUS Poor Data	5.2E-3	0		-30	-47		
CONUS Median Voice	1.1E-2	0		-33	-51		
CONUS Median Data	3.2E-4	1.0E-5		-34	-48		

Case 1 - NSA Parameters
Case 2 - Same except harmonic distortion for CONUS reduced to match Melbourne loops. European phase jitter reduced to match European phase jitter measurements from 16 kb/s tests.
Case 3 - Same as 2 except CONUS distortion reduced 3 dB to simulate one-way calls rather than loops.

2.4 Synchronization Results

During Phase II the normal procedure for placing calls was to establish a connection and then send a modem synchronization signal. If the modems successfully synchronized, a second synchronization signal was sent and five BER values were recorded. If the synchronization signal was not received correctly, synchronization signals were sent until two consecutive successful synchronizations were achieved. Table 2.4-1 shows the synchronization attempts and the syncrhonization failures for the 16 kb/s modems on calls from different locations. Thus from MacDill to the Pentagon out of 332 attempts there were 14 times that the modem did not synchronize to the error rate that it was capable of achieving on that channel. In all the 16 kbps modem missed 34 synchronizations out of 1468 attempts or a 9.7 percent success rate. Appendix C lists the specific attempts and successes for each cell in Phase II.

The synchronization performance of the 9.6 kb/s modem and of the 8 kb/s modem was not tabulated in Appendix C since it was taken on a small subset of the calls and hence is not felt to representative. However, in all, the 9.6 kb/s modem missed sync on 28 of the 172 attempts in which it was involved for a 83.7 percent success rate. The 16 kb/s modem when operating in the 8 kb/s mode missed sync 5 times out of 168 attempts for a 97.0 percent success rate.

Table 2.4-1. Synchronization Performance

Locations	Attempts	Misses	% Success
MacDill-Pentagon	332	14	95.8
Offutt-Pentagon	441	8	98.2
March-Melbourne	144	2	98.6
March-Pentagon	115	1	99.1
March-Ft. Meade	80	3	96.2
Pentagon Loops	213	3	98.6
MacDill Loops	14	0	100.0
Offutt Loops	16	0	100.0
March Loops	56	3	94.6
Ft. Meade Loops	57	0	100.0
	1468	34	97.7

SECTION 3.0

CONCLUSIONS AND RECOMMENDATIONS

3.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions were made based upon the test data presented:

1. The 16 kb/s modem performance was excellent on Autovon calls in areas where good access lines were available. Selected access lines require upgrading.
2. The conclusions from the test performance on the direct distance dial network are similar to those on Autovon in that the performance is good provided good access lines exist.
3. Tests were not conducted on the Federal Telephone System due to lack of time but since the FTS facilities are similar to those supplied to the VON and DDD networks it is reasonable to assume that the results would be the same.
4. Operation at lower rates (9.6 kb/s and 8 kb/s) was generally good even on the bad access lines from a statistical point of view. This information should not be used to argue that good 9.6 or 8 kb/s operation could be achieved without upgrade on some access lines. However:

The following recommendations are made:

1. The impact of upgrading Autovon access lines should be evaluated.
2. Analysis of the civil networks (DDD/FTS in areas of BSVN subscribers) should take place and an assessment made as to the cost impact of upgrading access lines where this appears necessary.
3. Further 16 kpbs modem testing over the FTS network is recommended to verify the assumptions made in this report.

APPENDIX A

PHASE IV DATA

APPENDIX A

PHASE IV DATA

This Appendix presents a detailed listing of the data obtained in Phase IV on four-wire Autovon loop-around and dial-through calls from the Harris plant in Melbourne, Florida. In most cases, ten separate calls were placed on a particular dialed routing. Five values of BER were recorded on each call for each connection. The values listed in the table are the median BER value of the five recorded.

The data contained within this section was collected by the contractor and not witnessed by the test committee. However, it was coordinated with the test director and it was agreed that this information would provide insight into understanding the tandem phenomena.

Table A-1 lists the data obtained on off-hour loops from Melbourne to the switch indicated. The median BER listed were obtained in sequence during the time indicated with the right-hand column preceding the left-hand columns.

Table A-2 lists the data obtained from busy-hour loops from Melbourne. The estimate of the probability of the number of switches involved was derived from data presented in a statistical network report from DCA. This document lists the IST connections for CONUS Autovon switches and the grade of service during busy hours for these trunk connections. The grade of service has been interpreted as the probability of blockage on a call. Hence, in cases where a switch is dialed that has IST connections to Polk City the probability of a three switch loop is

Table A-1. Off-Hours Loops (3 Switch Calls)

Seguin, Texas
P (3) = 1
Time: 2018-2030
Date: Thursday, May 25
MED BER Values

3.2-3	4.5-3
7.6-4	1.5-4
0	1.0-4
7.0-5	2.0-4
6.0-4	2.1-3

Mosely, Virginia
P (3) = 1
Time: 2032-2044
Date: Thursday, May 25
MED BER Values

8.0-4	2.2-4
1.3-4	1.7-4
2.6-4	6.0-5
9.0-5	1.0-4
6.9-4	1.7-4

Jasper, Alabama
P (3) = 1
Time: 2046-2058
Date: Thursday, May 25
MED BER Values

0	5.0-5
0	0
0	2.0-5
0	3.0-5
0	7.0-5

Drainsville, Virginia
P (3) = 1
Time: 2059-2111
Date: Thursday, May 25
MED BER Values

0	1.0-5
2.0-5	5.0-5
3.0-5	0
3.0-5	0
0	2.0-5

Arlington, Virginia
P (3) = 1
Time: 2113-2125
Date: Thursday, May 25
MED BER Values

6.0-5	1.0-5
2.3-4	3.0-5
6.0-5	3.0-5
5.0-5	1.0-5
4.0-5	5.0-1

Table A-1. Off-Hours Loops (5 Switch Calls)

Pottstown, PA
P (5) = 1
Time: 1530-1550
Date: Sunday, February 19
MED BER Values

2.7-3	1.8-3
4.3-3	3.2-3
2.2-3	2.3-3
1.4-3	8.4-4
2.4-3	4.9-3

Netcong, N.J.
P (5) = 1
Time: 1552-1608
Date: Sunday, February 19
MED BER Values

6.4-3	3.7-3
5.4-4	4.5-3
5.7-3	9.1-4
3.4-3	3.2-3
3.4-4	9.1-3

Chesterfield, MA
P (5) = 1
Time: 1511-1526
Date: Sunday, February 19
MED BER Values

1.5-3	2.5-3
3.0-4	1.8-3
4.3-3	5.1-3
1.1-3	1.7-3
1.4-2	1.2-3

Mojave, CA
P (5) = 1
Time: 1035-1049
Date: Friday, February 17
MED BER Values

4.2-3	6.3-3
2.6-3	5.2-3
5.9-3	3.8-3
3.3-3	9.9-3
2.2-2	1.5-3

Littleton, MA
P (5) = 1
Time: 1453-1508
Date: Sunday, February 19
MED BER Values

7.6-3	3.9-3
6.2-3	6.0-3
7.3-3	5.2-3
2.8-3	2.9-3
1.6-3	1.0-2

Toledo Junction, OH
P (5) = 1
Time: 1629-1649
Date: Sunday, February 19
MED BER Values

2.2-3	1.5-3
8.3-3	7.4-4
5.7-4	3.0-3
3.4-4	5.3-4
4.6-3	4.1-4

San Louis Obispo, CA
P (5) = 1
Time: 1020-1033
Date: Friday, February 17
MED BER Values

1.0-3	1.2-3
1.1-3	1.0-3
1.0-3	2.3-2
2.7-3	7.9-4
7.9-4	1.3-3

Mojave, CA
P (5) = 1
Time: 2128-2140
Date: Thursday, May 25
MED BER Values

7.6-3	5.8-3
6.6-3	4.6-3
5.6-3	4.1-3
7.5-3	4.4-3
6.8-3	5.6-3

Table A-1. Off-Hours Loops (5 Switch Loops)
(Continued)

Julian, CA
P (5) = 1
Time: 0808-0824
Date: Tuesday, May 30
MED BER Values

2.7-3	6.3-3
3.9-3	4.5-3
3.5-3	5.0-3
4.1-3	5.7-3
4.3-3	5.0-1

Hagerstown, MD
P (5) = .67 P (7) = .33
Time: 1653-1715
Date: Sunday, February 19
MED BER Values

1.9-3	9.0-4
1.1-2*	2.8-3
1.4-3	3.1-1*
3.7-3	2.4-3
4.5-2*	2.1-3

Fredericton, NB
P (5) = .33 P (7) = .67
Time: 1717-1734
Date: Sunday, February 19
MED BER Values

2.8-2*	1.8-2*
5.8-4	2.9-1*
2.6-2*	5.2-4
3.6-2*	1.1-2*
9.2-4	2.6-2*

Table A-1. Off-Hours Loops (7 Switch Calls)

Sherbrooke, QUE
P (7) = 1
Time: 1919-1947
Date: Thursday, May 25
MED BER Values

2.6-2	1.8-2
4.7-2	2.6-2
2.7-2	5.0-1
2.6-2	2.0-2
2.8-2	2.0-2
2.1-2	2.7-2
1.9-2	2.9-2
1.9-2	3.4-2
1.7-2	3.0-2
1.8-2	2.6-2

Smith Falls, ONT
P (7) = 1
Time: 1948-2015
Date: Thursday, May 25
MED BER Values

2.2-2	1.6-2
2.5-2	3.1-2
2.5-2	2.9-2
3.0-2	2.4-2
2.8-2	2.2-2
2.2-2	2.0-2
2.6-2	1.7-2
2.3-2	1.6-2
2.5-2	1.8-2
2.4-2	1.6-2

Table A-2. Busy-Hour Loops (3-5 Switch Loops)

Brewton, AL
P (3) = .85 P (5) = .15
Time: 1429-1445
Date: Monday, February 20
MED BER Values

1.2-4	4.0-5
1.2-4	1.0-5
4.0-5	1.2-4
3.0-5	4.0-5
8.0-5	

Mosely, VA
P (3) = .83 P (5) = .17
Time: 0950-1007
Date: Monday, February 20
MED BER Values

8.0-5	7.0-5
4.0-5	1.4-4
2.3-4	1.4-4
1.1-4	1.2-4
3.6-4*	1.2-4

Memphis Junction, AK
P (3) = .77 P (5) = .23
Time: 1523-1536
Date: Friday, February 17
MED BER Values

0	0
0	0
0	0
0	0
1.0-5	1.0-5

Drainsville, VA
P (3) = .67 P (5) = .33
Time: 1446-1502
Date: Monday, February 20
MED BER Values

2.8-4*	7.0-5
1.4-4	1.3-4
5.0-4*	2.1-4*
6.0-5	3.0-5
9.0-5	2.0-5

Ellisville, FL
P (3) = .84 P (5) = .16
Time: 1504-1522
Date: Monday, February 20
MED BER Values

2.1-4	1.4-4
7.0-5	1.8-4
1.6-4	3.0-5
7.0-5	1.2-4
3.0-5	3.0-4

Stanfield, NC
P (3) = .82 P (5) = .18
Time: 1042-1058
Date: Monday, February 20
MED BER Values

5.6-4*	3.0-5
8.0-5	4.0-5
1.0-4	5.4-4*
5.0-5	1.5-4
1.0-4	1.0-5

Seguin, TX
P (3) = .73 P (5) = .27
Time: 1507-1521
Date: Friday, February 17
MED BER Values

6.0-5	0
4.0-5	1.0-5
3.0-5	0
0	2.0-5
3.0-5	5.0-5

Jasper, AL
P (3) = .66 P (5) = .34
Time: 1402-1427
Date: Monday, February 20
MED BER Values

3.0-5	7.0-5
6.0-5	1.9-4
1.0-4	8.0-5
1.4-4	1.7-2*
1.8-4	7.5-4*

Table A-2. Busy-Hour Loops (3-5 Switch Loops)
(Continued)

Sweetwater, TX
P (3) = .65 P (5) = .35
Time: 1437-1450
Date: Friday, February 17
MED BER Values

2.0-5	0
2.0-5	2.0-5
7.0-5	0
0	2.0-5
0	5.0-5

Chatham, NC
P (3) = .53 P (5) = .47
Time: 1345-1400
Date: Monday, February 20
MED BER Values

2.8-4*	9.0-5
1.4-4	6.0-5
2.7-4*	3.2-4*
1.1-4	3.1-4*
2.2-4*	

Socorra, NM
P (3) = .50 P (5) = .50
Time: 1423-1435
Date: Friday, February 17
MED BER Values

3.3-3*	3.0-5
1.9-2*	3.0-5
1.4-4	2.1-4*
2.4-4*	1.2-4
6.0-5	8.0-5

Arlington, VA
P (3) = .73 P (5) = .27
Time: 1317-1544
Date: Monday, May 16
MED BER Values

3.8-3*	0
0	7.6-4*
5.0-5	5.0-5
4.0-5	6.0-4*
9.3-3*	0

Table A-2. Busy-Hour Loops (5-7 Switches)

Leesburg, VA
P (5) = .89 P (7) = .11
Time: 1024-1040
Date: Monday, February 20

MED BER Values	
6.5-4	4.8-3
4.3-3	1.7-1*
1.9-1*	7.7-4
1.2-3	4.2-3
6.2-3	

Cedar Brook, NJ
P (5) = .88 P (7) = .12
Time: 1610-1625
Date: Monday, February 20

MED BER Values	
1.1-3	1.1-2*
2.4-3	6.4-4
6.6-3	9.1-3*
5.7-4	5.9-3
1.6-3	1.4-3

Williamstown, KY
P (5) = .86 P (7) = .14
Time: 0930-0948
Date: Monday, February 20

MED BER Values	
2.2-3	1.2-3
1.2-3	5.2-4
2.3-3	1.4-3
9.9-4	7.5-4
1.5-3	1.1-3

Charlottesville, VA
P (5) = .72 P (7) = .28
Time: 1009-1023
Date: Monday, February 20

MED BER Values	
2.1-3	5.4-3
2.9-3	3.0-3
5.3-3	5.3-3
2.3-3	4.6-3
4.0-3	4.9-3

Lamar, CO
P (5) = .59 P (7) = .41
Time: 1334-1350
Date: Friday, February 17

MED BER Values	
1.7-3	4.9-1*
9.0-2*	2.9-3
2.8-3	8.5-2*
1.1-2*	6.0-3
2.5-3	2.8-3

Tulley, NY
P (5) = .57 P (7) = .43
Time: 1610-1625
Date: Friday, February 17

MED BER Values	
6.7-3	6.1-3
8.1-3	1.0-2*
2.6-2*	5.4-3
2.4-2*	4.5-3
3.3-3	5.7-3

Mounds, OK
P (5) = .55 P (7) = .45
Time: 1319-1332
Date: Friday, February 17

MED BER Values	
2.9-3	8.1-3*
2.3-3	2.6-3
3.9-3	1.1-3
3.0-3	2.1-3
3.0-3	3.0-3

Dover-Foxcroft, ME
P (5) = .50 P (7) = .50
Time: 1646-1700
Date: Friday, February 17

MED BER Values	
2.3-3	2.7-3
1.0-2*	3.9-3
8.3-4	9.6-3*
7.8-3*	2.2-3
7.5-3*	4.9-4

Table A-2. Busy-Hour Loops (5-7 Switches) (Continued)

Apache Junction, AR
P (5) = .44 P (7) = .56
Time: 1408-1421
Date: Friday, February 17
MED BER Values

3.3-3	2.5-2*
3.9-2*	2.9-3
1.0-3	1.1-3
7.0-3*	2.0-3
2.4-2*	3.8-3

San Luis Obispo, CA
P (5) = .43 P (7) = .57
Time: 1436-1629
Date: Friday, May 12
MED BER Values

3.0-3	9.6-4
1.0-3	5.3-4
1.4-3	1.2-3
2.1-3	6.8-4
1.1-3	1.4-2*

Lyons, NE
P (5) = .35 P (7) = .65
Time: 1259-1317
Date: Friday, February 17
MED BER Values

3.4-3	3.5-3
1.4-3	1.1-3
5.3-2*	1.0-2*
4.3-3	1.9-1*
4.3-2*	1.8-3

Stevens Pt., WI
P (5) = .19 P (7) = .81
Time: 1628-1644
Date: Friday, February 17
MED BER Values

4.8-3	6.1-3*
5.2-3	6.1-3*
1.0-2*	1.2-3
7.0-3*	1.4-2*
4.1-2*	7.1-3*

Lodi, CA
P (5) = .44 P (7) = .56
Time: 1106-1241
Date: Friday, February 17
MED BER Values

4.5-3	3.4-1*
1.4-2*	4.2-3
9.8-3*	1.3-2
1.5-2*	6.5-3
7.8-3	2.7-2*

Julian, CA
P (5) = .42 P (7) = .58
Time: 1051-1104
Date: Friday, February 17
MED BER Values

4.4-3	3.4-2*
2.1-2*	3.3-2*
1.6-2*	1.0-1*
3.0-2*	5.4-2*
2.9-2*	3.4-3

Helena, MT
P (5) = .20 P (7) = .80
Time: 1244-1258
Date: Friday, February 17
MED BER Values

1.4-3	3.9-2*
3.5-2*	2.3-2*
4.8-2*	7.2-2*
2.4-3	7.4-3*
4.9-2*	1.3-3

CMC, CO
P (5) = .17 P (7) = .83
Time: 1352-1406
Date: Friday, February 17
MED BER Values

3.6-3	2.8-3
3.1-2*	4.2-3
1.9-2*	6.7-3*
1.9-3	1.4-2*
1.3-2*	2.4-1*

Table A-2. Busy-Hour Loops (5-7 Switches) (Continued)

Fredericton, NB

P (5) = .19 P (7) = .81
Time: 0851-0930
Date: Friday, February 17

MED BER Values	
6.1-4	8.6-2*
1.9-2*	2.7-2*
9.5-2*	9.5-2*
1.5-2*	1.8-2*
5.4-3	1.6-2*
5.4-3	2.9-2*
1.3-2*	9.0-4
3.5-2*	1.8-2*
1.7-2*	2.3-2*
7.2-2*	8.1-3*

North Bend, WA

P (5) = .16 P (7) = .84
Time: 1632-1650
Date: Tuesday, May 16

MED BER Values	
2.1-3	8.1-3*
7.2-3*	1.6-2*
1.2-2*	9.6-3*
2.5-2*	7.7-3*
1.2-2*	1.7-2*

Yakima, WA

P (5) = .11 P (7) = .89
Time: 1352-1544
Date: Tuesday, May 16

MED BER Values	
1.1-2*	1.8-2*
1.1-2*	3.8-3
2.1-2*	3.8-3
2.9-2*	4.4-3
9.1-3*	2.7-3

Wyoming, MN

P (5) = .10 P (7) = .90
Time: 1538-1550
Date: Friday, February 17

MED BER Values	
5.8-3	5.2-3
4.8-3	8.9-3*
4.9-3	2.0-2*
4.7-3	9.6-3*
1.9-2*	2.1-3

Table A-2. Busy-Hour Loops (7-9 Switches)

Sherbrook, QUE
Time: 0843-1000
Date: Friday, February 17
MED BER Values

7.5-2*	1.5-1*
3.2-2	2.9-2
5.4-2*	4.3-2*
4.3-2*	2.6-2
2.7-2	3.2-2

Smith Falls, ONT
Time: 1001-1018
Date: Friday, February 17
MED BER Values

7.7-2*	1.9-2
7.0-2*	8.3-2*
3.2-2	1.1-2
7.9-2*	1.9-2
3.7-2	1.6-2

simply one minus the probability of blockage on those trunks. It is assumed that the remaining blocked calls will be routed in a manner that one extra switch is encountered in reaching the destination (this corresponds to two extra switches for loops since the signal must transit this switch in both directions).

The calculation of switch probability for the case where a loop is placed to a switch without IST connection to Polk City is more complex. In cases where three or more switches have IST's jointly to Polk City and the dialed switch, it is assumed that the probability is one that one of these switches is reached and the probability of picking up an extra switch is the probability that the IST's to the terminal switch are blocked. This latter probability was calculated as the average blockage probability associated with the three switches in the above mentioned category that are closest to the destination switch. Although this is admittedly an approximation to the actual blockage probability it was felt to be the best estimate that could be obtained from the information available and was sufficiently accurate to indicate the correlation between BER and the probable number of switches. In most cases the specific choice as to which switches are part of the most direct triple has little significant impact on the estimated blockage probability.

In cases where only two switches had IST's connecting Polk City with the destination switch, the probability of reaching one of these switches was assessed as 2/3 times one minus the average blockage probability of the IST's to these switches. The probability of these reaching the final destination without an extra switch was calculated as one

minus the average blockage probability from the two switches in question to the destination switches. The probability of getting to the final switch without an extra switch intervening is the product of the two calculations and the probability of an extra switch (two in loop around) is one minus that quantity. The calculation for case where only one intervening switch has mutual IST's between the source and destination follows the same procedure except that 1/3 rather 2/3 is used in the calculation.

Calculation of switch probabilities for dial-through calls is accomplished by calculating the probability of an extra switch independently for each dialed leg of the call. The calculation as to the probable number of additional switches is then obtained by summing the probabilities associated with each of the possible ways that zero, one, two, etc., additional switches can occur. It is assumed, as before, that each leg can only add one additional switch.

In Table A-2 asterisks have been placed by BER values that might correspond to the larger number of switches. Although this represents only a guess it is interesting to note the correlation between asterisks and the switch probabilities. It is also interesting to note the correlation between the BER values without asterisks and those measured with that number of switches during off hours.

Table A-3 lists median BER values for dial-through calls in off hours. The dial-through calls were made using two modems and an error rate was recorded on each connection of a call. In Table A-3, the left-hand column corresponds to the error rate on one of the connections and the right-hand column the error rate on the other. Thus, the ten calls resulted

Table A-3. Off-Hours Dial-Through Calls (3 Switch Calls)

Arlington, VA
Time: 0148-0205
Date: Tuesday, May 23
MED BER Values

0	7.0-4
0	2.2-4
2.0-5	5.0-1
5.0-1	1.6-4
1.0-5	3.0-5
0	1.1-4
0	3.0-5
1.8-4	5.0-5
1.0-5	2.2-4
2.0-5	1.7-4

Drainsville, VA
Time: 0208-0221
Date: Tuesday, May 23
MED BER Values

0	1.0-5
0	0
0	4.0-5
0	0
0	1.0-5
3.8-2	0
0	0
0	1.0-5
0	5.0-5
0	0

Jasper, AL
Time: 0224-0237
Date: Tuesday, May 23
MED BER Values

0	9.0-5
4.0-5	4.0-5
3.0-5	7.0-5
3.0-5	1.2-4
0	5.0-5
3.0-5	4.0-5
6.0-5	1.3-4
2.0-5	1.0-5
3.0-5	5.0-5
4.0-5	9.0-5

Mosely, VA
Time: 0239-0253
Date: Tuesday, May 23
MED BER Values

4.0-5	1.0-4
8.0-5	9.0-5
2.7-4	1.3-4
1.3-4	1.6-4
1.0-4	5.0-5
6.0-5	2.1-4
7.0-5	6.0-5
4.0-5	8.0-5
5.0-5	9.0-5
4.0-5	7.0-5

Seguin, TX
Time: 0257-0308
Date: Tuesday, May 23
MED BER Values

1.9-3	2.5-4
8.7-3	5.0-5
4.3-3	1.1-4
1.0-4	4.4-4
1.5-4	3.7-4
2.2-4	6.2-4
4.0-5	1.4-4
2.0-5	2.6-4
2.4-4	2.3-4
1.9-3	1.6-3

Table A-3. Off-Hours Dial-Through Calls (5 Switch Calls)

X-SLO-X
Time: 1947-2007
Date: Monday, May 22
MED BER Values

1.6-3	2.3-3
1.9-3	4.5-3
1.3-3	2.8-3
1.5-3	5.8-3
1.6-3	2.2-3
1.0-3	1.1-3
7.1-4	1.0-3
2.4-3	1.3-3
1.7-3	1.3-3
4.2-3	1.0-3

X-POT-X
Time: 2010-2029
Date: Monday, May 22
MED BER Values

2.1-3	1.6-3
1.7-3	1.2-3
2.5-3	1.0-3
2.4-3	8.3-4
1.4-3	9.1-4
1.8-3	1.3-3
1.8-3	1.9-3
1.7-3	1.6-3
1.7-3	1.6-3
1.2-3	1.7-3

X-NOR-X
Time: 2032-2047
Date: Monday, May 22
MED BER Values

2.6-3	3.9-3
4.5-3	3.0-3
3.8-3	2.7-3
2.9-3	3.6-3
4.7-3	2.6-3
4.2-3	2.8-3
4.3-3	2.0-3
4.2-3	2.5-3
3.9-3	3.2-3
5.9-3	3.6-3

SEQ-SLO-ARL
Time: 2050-2112
Date: Monday, May 22
MED BER Values

5.2-3	1.5-3
3.8-3	2.6-3
1.0-2	5.1-3
2.0-2	1.8-3
1.2-2	1.7-3
5.1-3	2.7-3
2.2-3	5.0-1
1.6-3	5.0-1
2.5-3	4.5-3
5.4-3	3.6-3

DRA-POT-MOS
Time: 2116-2136
Date: Monday, May 22
MED BER Values

1.4-3	2.9-3
7.6-4	3.3-2
7.6-4	1.7-3
6.4-4	3.6-3
4.0-4	3.8-3
1.5-2	3.6-3
4.8-3	3.6-4
3.6-3	8.4-4
3.4-3	7.8-4
3.5-3	7.3-4

JAS-NOR-DRA
Time: 2140-2158
Date: Monday, May 22
MED BER Values

3.3-3	1.2-3
3.0-3	1.0-3
4.0-3	1.7-3
3.3-3	1.7-3
4.6-3	2.4-3
5.0-1	5.0-1
2.3-3	3.2-3
2.2-3	2.8-3
2.0-3	3.4-3
2.8-3	3.5-3

Table A-3. Off-Hours Dial-Through Calls (7 Switch Calls)

X-SLO-X-POT-X
Time: 2206-2226
Date: Monday, May 22
MED BER Values

8.1-3	5.8-3
6.6-3	7.0-3
7.2-3	6.9-3
5.8-3	8.4-3
9.3-3	9.8-3
8.8-3	2.6-1
1.0-2	6.7-3
1.0-2	6.4-3
9.2-3	7.2-3
1.8-2	5.6-3

X-SLO-X-NOR-X
Time: 2230-2252
Date: Monday, May 22
MED BER Values

1.4-2	2.1-2
1.3-2	1.9-2
1.3-2	1.8-2
1.6-2	2.4-2
1.6-2	2.8-2
2.9-2	1.0-2
2.8-2	1.0-2
2.7-2	1.1-2
5.0-1	1.1-2
2.1-2	1.2-2

X-POT-X-SLO-X
Time: 2255-2313
Date: Monday, May 22
MED BER Values

6.2-3	8.1-3
4.4-3	8.2-3
3.4-3	6.7-3
5.6-3	9.1-3
8.8-3	5.6-3
1.2-2	7.9-3
9.9-3	5.8-3
1.1-2	5.6-3
1.0-2	6.1-3
1.3-2	3.5-3

X-NOR-X-POT-X
Time: 2315-2334
Date: Monday, May 22
MED BER Values

1.8-2	1.3-2
1.3-2	1.0-2
1.6-2	1.0-2
2.5-2	1.2-2
1.4-2	1.2.2
1.8-2	1.1-2
1.8-2	9.1-3
1.5-2	1.0-2
1.4-2	9.5-3
1.7-2	6.5-3

MOS-X-SLO-X-JAS
Time: 0001-0020
Date: Tuesday, May 23
MED BER Values

2.4-2	6.7-3
2.3-2	9.3-3
2.8-2	1.1-2
2.3-2	1.1-2
1.7-2	8.3-3
1.7-2	1.2-2
1.9-2	1.2-2
1.6-2	1.2-2
1.5-2	1.1-2
1.6-2	1.3-2

JAS-X-POT-X-SEG
Time: 0045-0103
Date: Tuesday, May 23
MED BER Value

2.8-2	1.3-2
2.9-2	2.1-2
1.5-2	1.1-2
2.7-2	1.5-2
2.1-2	1.9-2
2.1-2	1.7-2
2.1-2	1.7-2
1.9-2	1.4-1
2.8-2	2.5-2
1.8-2	2.1-2

Table A-3. Off-Hours Dial-Through Calls (7 Switch Calls)
(Continued)

X-X-YAR-XX*
Time: 0310-0325
Date: Tuesday, May 23
MED BER Values

2.3-2	3.0-2
1.7-2	3.1-2
2.2.2	3.5-2
2.2.2	2.6-2
1.9-2	2.5-2
2.3-2	2.3-2
2.4-2	2.2-2
1.8-2	2.4-2
1.8-2	2.2-2
2.3-2	2.3-2

Table A-3. Off-Hours Dial-Through Calls (9 Switch Calls)

X-POT-X-SLO-X-NOR-X
Time: 0105-0125
Date: Monday, May 22
MED BER Values

2.1-2	2.5-2
2.4-2	2.7-2
1.6-2	2.6-2
1.4-2	2.3-2
1.0-2	3.0-2
3.4-2	1.3-2
5.0-2	1.5-2
4.7-2	1.6-2
5.1-2	1.6-2
3.9-2	1.3-2

X-SLO-X-POT-X-NOR-X
Time: 0128-0145
Date: Monday, May 22
MED BER Values

3.3-2	2.3-2
2.9-2	2.4-2
2.8-2	3.0-2
3.2-2	2.8-2
2.5-2	2.7-2
3.4-2	2.3-2
3.7-2	2.4-2
3.6-2	2.5-2
4.7-2	2.3-2
6.8-2	7.1-2

in 20 connections and, hence, 20 BER values. The first five calls were dialed from the phone which was connected to the modem whose received BER values are indicated in the left-hand column. The last five calls were dialed from the other phone. Table A-4 lists 20 BER values obtained on a busy-hour call to San Luis Obispo.

Table A-4. Busy-Hours Dial-Through Calls (5-7 Switch Calls)

San Luis Obispo, CA
P (5) = P ( ) =
Time: 1440-1629
Date: Friday, May 12
MED BER Values

3.7-3	5.6-3
6.3-4	1.6-3
1.3-3	6.3-3
8.2-4	1.8-3
1.4-2*	1.0-2*
7.0-4	1.9-3
9.9.3*	3.4-3*
1.0-3	1.2-3
1.0-3	2.0-3
8.6-4	9.8-4

APPENDIX B

TEST RESULTS - SITE SURVEY

APPENDIX B

TEST RESULTS - SITE SURVEY

This Appendix presents the results of Phase I (the site survey) tests in chronological order. The call numbering is consecutive for each site.

The test results presented use the following nomenclature:

1. Access Lines - The access line numbers listed are in a variety of forms. The principal intent is to indicate when the same or different access lines are used.
2. Type - The calls to Melbourne are indicated as either one-way full duplex (FD) or one-way half duplex (HD) depending upon whether the transmissions to and from Melbourne are simultaneous or sequential.
3. All error rates given for one-way calls are those measured at the site listed. Error rates measured in Melbourne will be collated later.
4. The Transmit Signal Levels given are those existing at Melbourne for one-way calls and those existing at the site for loop-around calls. In all cases, they represent the best estimate of levels in dBm0 or levels that would exist at an OTLP point at the first switch.
5. The receive levels given are those existing at the site (also in dBm0) for Autovon calls. For commercial calls the receive level is given in dBm since the loss to the switch is unknown.

6. The abbreviation (SVC) indicates an AutoSevoCom line and the abbreviation (AV) indicates an Autovon line. The abbreviation (DDD) indicates a commercial call placed by direct dial or credit card call.
7. The abbreviation (2W) indicates a two-wire circuit.
8. The bit error rates given are the median values of the multiple 100,000 bit counts taken on each call configuration. The BER values received in Melbourne are based on the median of five 10-second counts.

Tests from Pentagon - 13 March

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
1.	Williamstown, KY	Loop		2.1E-3	JUDN-LYQV(SVC)	Cable	ARL	-13					0918
2.	Polk City, FL	Loop		2.4E-3	JUDN-LYQV(SVC)	Cable	ARL	-13					0924
3.	CMC, CO	Loop		9.4E-3	JUDN-LYQV(SVC)	Cable	ARL	-13					0930
4.	San Luis Obispo, CA	Loop		2.9E-3	JUDN-LYQV(SVC)	Cable	ARL	-13					0936
5.	Lyons, NE	Loop		1.1E-2	JUDN-LYQV(SVC)	Cable	ARL	-13					0942
6.	Mojave, CA	Loop		8.9E-3	JUDN-LYQV(SVC)	Cable	ARL	-13					0948
7.	Julian, CA	Loop		2.8E-3	JUDN-LYQV(SVC)	Cable	ARL	-13					0954
8.	Helena, MT	Loop		1.3E-2	JUDN-LYQV(SVC)	Cable	ARL	-13					1000
9.	Melbourne, FL	One-1006 Way (FD)	6.2E-5	0	JUDN-LYQV(SVC)	Cable				ARL	-19	-17	
10.	Melbourne, FL	One-1024 Way (FD)	1.8E-4	1.0E-5	JUDN-LYQV(SVC)	Cable				ARL	-19	-17	
				2.4E-3	JUDN-LYQV(SVC)	Cable	ARL	-7	-8				
				1.6E-3	JUDN-LYQV(SVC)	Cable	ARL	-10	-11				
				3.0E-4	JUDN-LYQV(SVC)	Cable	ARL	-13	-14				
11.	Melbourne, FL	One-1054 Way (FD)	1.7E-4	3.8E-4	LYQW(SVC)	Cable				ARL	-7	-8	
				5.1E-4	LYQW(SVC)	Cable	ARL	-13	-13				
12.	Melbourne, FL	One-1112 Way (FD)	1.0E-4	1.4E-4	LYQT(SVC)	Cable				ARL	-13	-13	
				3.0E-5	LYQT(SVC)	Cable	ARL	-7	-8				
13.	Melbourne, FL	One-1124 Way (FD)	2.1E-4	2.0E-4	LYQU(SVC)	Cable				ARL	-10	-11	
				1.5E-4	LYQU(SVC)	Cable	ARL	-7	-8				

Tests from Pentagon - 13 March (Continued)

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
14.	Williamstown, KY	Loop		1.0E-2	64490-126(VC)	Cable	ARL	-13					1342
15.	Williamstown, KY	Loop		1.9E-3	64490-127(VC)	Cable	ARL	-13					1348
16.	Williamstown, KY	Loop		4.1E-3	64490-128(VC)	Cable	ARL	-13					1354
17.	Williamstown, KY	Loop		1.0E-2	64490-129(VC)	Cable	ARL	-13					1400
18.	Drainsville, VA	Loop		0	43100-127(VC)	Cable	DRA	-13					1406
19.	Drainsville, VA	Loop		2.0E-5	43100-128(VC)	Cable	DRA	-13					1412
20.	Drainsville, VA	Loop		5.7E-4	43100-130(VC)	Cable	DRA	-13					1418
21.	Drainsville, VA	Loop		1.1E-3	43100-132(VC)	Cable	DRA	-13					1424
22.	Drainsville, VA	Loop		6.0E-5	43100-138(VC)	Cable	DRA	-13					1430
23.	Drainsville, VA	Loop		9.0E-5	43100-144(VC)	Cable	DRA	-13					1437
24.	Williamstown, KY	Loop		8.5E-2	43100-144(VC)	Cable	DRA	-13			35db	23db	1443
25.	Charlottes-ville, VA	Loop		2.6E-2	43100-144	Cable	DRA	-13			32db	24db	1447
26.	Mosely, VA	Loop		4.0E-2	43100-14	Cable	DRA	-13					1453
27.	Charlottes-ville, VA	Loop		1.6E-2	64490-129	Cable	ARL	-13		29db	35db	32db	1459
28.	Williamstown, KY	Loop		2.9E-2	64490-129	Cable	ARL	-13		33db	40db	27db	1505

Notes: Calls 1-13 were placed from the AutoSevoCom Switch Area.
Calls 14-28 were placed from the ATT Test Facility Area.
Call Number 11 required a second sync to achieve BER shown.
Calls Numbers 14-17 and 24-28 showed evidence of Echo Suppressor. On two of the calls an attempt was made to disable the echo suppressor by use of a 2025 Hz tone.

Tests from Ft. Meade - 14 March

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	2nd	3rd	Time
1.	FANEX SWBD	Loop		0	-	Wire	-	-13						0934
2.	Baltimore	Loop		1.0E-1	2W-DDD		794 Exchange	-13	-21	0^o	43db	49db	40db	0935
				1.4E-4	2W-DDD (Inserted 6 db pad after training modem)									
3.	Main Bldg.	Loop		8.0E-2	2W	TI-(DIA)	-	-25	-29	10^o	20db	28db	36db	1040
4.	Main Bldg.	Loop		8.3E-2	2W	TI-(DIA)	-	-22	-24					1100
				6.5E-2	2W	TI-(DIA)	-	-25	-29					
				9.0E-2	2W	TI-(DIA)	-	-13	-19					
				5.6E-2	2W	TI-(DIA)	-	-16	-20					
				6.5E-2	2W	TI-(DIA)	-	-19	-22	9^o	21db	31db	∞	
5.	Baltimore	Loop		5.0E-4	2W-DDD		794 Exchange	-19						1115
				2.8E-4	2W-DDD		794 Exchange	-13						
6.	Baltimore	Loop		1.0E-5	2W-DDD		794 Exchange	-13						1121
7.	Baltimore	Loop		4.6E-4	2W-DDD		794 Exchange	-13						1127
8.	Baltimore	Loop		2.0E-5	2W-DDD		794 Exchange	-13						1133
9.	Melbourne	One-Way (HD)		2.0E-1	2W	TI-(DIA)	MON	-13	-20	6^o	23db	28db	22db	1255
10.	Melbourne	One-Way (HD)		1.3E-1	2W	TI-(DIA)	MON	-13						1301
11.	Melbourne	One-Way (HD)	2.2E-3	6.0E-3	2W-DDD	Watts Exchange	794	-13						1310
12.	Melbourne	One-Way (HD)	1.6E-2	3.0E-2	2W-DDD	Watts Exchange	794	-13						1316
13.	Washington	Loop		4.2E-2	2W-DDD	TI-(DIA)	Laurel Exchange	-13	-20	13^o	17-27db	30db	36db	1500

Tests from Ft. Meade - 14 March (Continued)

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	2nd	3rd	Time
14.	Baltimore	Loop		0	2W-DDD	Watts	Balt. Exchange	-13	-19	0^{o}	45db	63db	51db	1506
15.	Atlanta	Loop		9.5E-2	2W-DDD	TI-(DIA)	Laurel Exchange	-13	-33	6^{o}	27db	33db	34db	1512
16.	Melbourne	One-Way (HD)		2.3E-3	2W-DDD	Watts	Balt. Exchange	-13	-24					1518
17.	Melbourne	One-Way (HD)		2.1E-3	2W-DDD	Watts	Balt. Exchange	-13	-26					1524
18.	Melbourne (OB)	One-Way (HD)		8.9E-2	2W-DDD	TI-(DIA)	Laurel Exchange	-13	-30	5^{o}	26db	27db	27db	1653
19.	Melbourne (OB)	One-Way (HD)		1.1E-2	2W-DDD	TI-(DIA)	Laurel Exchange	-13	-27	6^{o}	24db	35db	29db	1659
20.	Melbourne (OB)	One-Way (HD)		7.3E-2	2W-DDD	TI-(DIA)	Laurel Exchange	-13	-36		28db	40db	29db	1705

Notes: Calls 1-12 were conducted using two 2-wire phones at the FANEX.
Calls 13-17 were conducted using two 2-wire phones at the MAIN BUILDING.
All Calls to the 794 Exchange in Baltimore from the FANEX indicated a transient condition at the beginning of the call.

Tests from Offut AFB - 15 March

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
1.	Lyons, NE	Loop		0	GP-77016-003(SVC)		LYO	-10						1430
2.	Lyons, NE	Loop		0	GP-77016-001(SVC)		LYO	-10						1433
3.	Lyons, NE	Loop		0	GP-77016-002(SVC)		LYO	-10						1436
4.	Lyons, NE	Loop		0	GP-77016-004(SVC)		LYO	-10						1439
5.	Lyons, NE	Loop		5.0E-5	GP-77016-005(SVC)		LYO	-10						1442
6.	Polk City,	Loop		3.0E-2	GP-77016-004(SVC)		LYO	-10						1445
	FL			4.7E-2	GP-77016-004(SVC)		LYO	-13	-13		31db	41db	29db	
7.	Polk City, FL	Loop		6.0E-2	GP-77016-004(SVC)		LYO	-13						1451
8.	Polk City, FL	Loop		5.5E-2	GP-77016-004(SVC)		LYO	-13						1457
9.	Polk City, FL	Loop		2.9E-2	GP-77016-004(SVC)		LYO	-13						1503
10.	Polk City, FL	Loop		4.0E-2	GP-77016-004(SVC)		LYO	-13						1509
11.	Polk City, FL	Loop		6.1E-2	GP-77016-005(SVC)		LYO	-13						1515
12.	Polk City, FL	Loop		5.8E-2	GP-77016-005(SVC)		LYO	-13						1521
13.	Polk City, FL	Loop		7.0E-2	GP-77016-005(SVC)		LYO	-13						1527
14.	Polk City, FL	Loop		4.8E-2	GP-77016-005(SVC)		LYO	-13						1533
15.	Polk City, FL	Loop		3.5E-2	GP-77016-005(SVC)		LYO	-13						1539
16.	Mosely, VA	Loop		2.4E-2	GP-77016-004(SVC)		LYO	-13						1548
17.	San Luis Obispo, CA	Loop		2.2E-2	GP-77016-004(SVC)		LYO	-13						1602

Tests from Offut AFB - 15 March (Continued)

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
18.	CMC, CO	Loop		9.9E-3	GP-77016-004(SVC)			LYO	-13					1606
19.	Helena, MT	Loop		7.3E-3	GP-77016-004(SVC)			LYO	-13					1610
20.	Mojave, CA	Loop		1.7E-2	GP-77016-004(SVC)			LYO	-13					1614
21.	Julian, CA	Loop		8.1E-3	GP-77016-004(SVC)			LYO	-13					1618
22.	Hagerstown, MD	Loop		5.3E-2	GP-77016-004(SVC)			LYO	-13					1620
23.	Airborne C.P.	Loop		2.0E-1				LYO	-13	-10	28db	38db	26db	1622
				8.8E-2(8KB)				LYO	-13					
				7.2E-2(8KB with Amp Tracker)				LYO	-13					
24.	San Louis Obispo, CA	Dial Thr.		9.9E-3	GP-77016-005(RCV) -001(Xmt)			LYO	-13					
				2.9E-2	GP-77016-001(RCV) -005(Xmt)			LYO	-13					1645
25.	Mosely, VA	Dial Thr.		1.9E-2	GP-77016-001(RCV) -005(Xmt)			LYO	-13					
				5.9E-3	GP-77016-005(Xmt) -001(RCV)			LYO	-13					

Tests from Offut AFB - 15 March (Continued)

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
26.	Melbourne, FL	One-Way (FD)	1.6-3	5.1E-3	GP-77016-005(SVC)		LYO	-10						0923
27.	Melbourne, FL	One-Way (FD)	4.0-3	9.8E-3	GP-77016-003(SVC)		LYO	-10						0930
28.	Melbourne, FL	One-Way (FD)	2.7-3	1.1E-2	GP-77016-003(SVC)		LYO	-10	-11	6°	29	31	30	0932
29.	Melbourne, FL	One-Way (FD)	2.1-3	1.4E-2	GP-77016-003(SVC)		LYO	-10	-11	6°	30	30	33	0944
30.	Melbourne, FL	One-Way (FD)	3.4-2	7.1E-3	GP-77016-003(SVC)		LYO	-10						0953
31.	Melbourne, FL	One-Way (FD)	2.0-2	3.3E-2	GP-77016-003(SVC)		LYO	-10						0956
32.	Melbourne, FL	One-Way (FD)	2.6-3	2.0E-2	GP-77016-003(SVC)		LYO	-10	-10	7°	29	29	31	1002
33.	Melbourne, FL	One-Way (FD)	3.8-3	1.0E-2	GP-77016-003(SVC)		LYO	-10						1006
34.	Melbourne, FL	One-Way (FD)	3.3-3	1.6E-2	GP-77016-003(SVC)		LYO	-10						1010
				1.1E-2	GP-77016-003(SVC)			LYO	-13					
35.	Melbourne, FL	One-Way (FD)	2.5-3	1.4E-2	GP-77016-003(SVC)		LYO	-13						1013
36.	Melbourne, FL	One-Way (FD)	2.0-3	1.2E-2	GP-77016-004(SVC)		LYO	-13						1016
37.	Melbourne, FL	O.T.-SLO	4.8-3	7.9E-3	GP-77016-004(SVC)		LYO	-13	-18					1026
38.	Melbourne, FL	One-Way (FD)	3.8-4	4.8E-3	GP-70016-003(SVC)		LYO	-13						1036
39.	Melbourne, FL	One-Way (FD)	1.9-3	1.0E-2	GP-70016-003(SVC)		LYO	-13						1046

Tests from Offut AFB - 16 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
40.	Melbourne, FL	One-Way (FD)		1.5E-2	GP-77016-003(SVC)		LYO	-13	-9	6°	29	29	30	1056
41.	Melbourne, FL	D.T. -SLO	1.2-2	2.6E-2	GP-77016-003(SVC)		LYO	-13	-15					1110
42.	Airborne C.P.			Loop	6.5E-2		LYO	-13						1155
				5.1E-4(8KB)			LYO	-13						
43.	Airborne C.P.			Loop	4.7E-2		FVW	-13						1205
				5.8E-3(8KB)			FVW	-13						
44.	Airborne C.P.			Loop	2.2E-2		FVW	-13						1210
				1.9E-3(8KB)			FVW	-13						
45.	Melbourne, FL	One-Way (FD)	2.2-3	2.8E-3	(AV1)		LYO	-13						
		One-Way (HD)		2.1E-3	(AV1)		LYO	-13						1312
46.	Melbourne, FL	One-Way (FD)	2.4-3	1.1E-3	(AV1)		LYO	-13						1322
47.	Melbourne, FL	One-Way (FD)	2.4-4	1.1E-3	(AV1)		LYO	-13						1332
48.	Melbourne, FL	One-Way (FD)	1.1-3	1.3E-3	(AV1)		LYO	-134						1342
49.	Melbourne, FL	One-Way (FD)	7.7-4	1.3E-3	(AV2)		FVW	-13						1352
		One-Way (HD)	1.0-3	1.3E-4	(AV2)		FVW	-13						1402
50.	Melbourne, FL	One-Way (FD)		8.0E-2	(AV2)	0	FVW	-13						1412
		One-Way (HD)		5.6E-4	(AV2)	7.0E-5	FVW	-13						1422
51.	Fairview, NE	Loop	0		(AV3)		FVW	-13						1432

Tests from Offut AFB - 16 March (Continued)

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
52.	Polk City, FL	Loop		5.2E-3	GP-77016-003(SVC) Side of SF		On Line	LYO	-13					1452
53.	Polk City, FL	Loop		5.2E-3	GP-77016-003(SVC) Side of SF		On Line	LYO	-13					1502
				1.8E-2	GP-70016-003(SVC) Side of SF		On User	LYO	-13					
54.	Melbourne, FL	One-Way		1.9E-1	2 Wat PBX			-13	-34					1543

Notes:
1. Calls 1-44 were placed at AutoSevoCom Switch
2. Calls 45-53 were placed at ATT Test Facility
3. Calls to Airborne Command Post (23, 42-45) exhibited rapid dispersive fades of several db in depth.
4. Calls 26-36 were placed with faulty modem in Melbourne (The frequency stability of the stable clock was off. This was adjusted for calls after Call 36.)
5. Call 54 was placed at the PBX.

Tests from Cheyenne Mt AFB - 17 March

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
1.	CMC, CO	Loop		4.0-5	4W1	Cable	CMC	-13					0836	
2.	Poik City, FL	Loop		6.5-3	4W1	Cable	CMC	-13					0840	
3.	Mosely, VA	Loop		1.4-2	4W1	Cable	CMC	-13					0844	
4.	Helena, MT	Loop		1.8-3	4W1	Cable	CMC	-13					0848	
5.	Mojave, CA	Loop		2.3-3	4W1	Cable	CMC	-13					0852	
6.	Julian, CA	Loop		6.0-3	4W1	Cable	CMC	-13					0856	
7.	Hagerstown, MD	Loop		4.3-2	4W1	Cable	CMC	-13					0900	
8.	Fredericton, NB	Loop		3.0-2	4W1	Cable	CMC	-13					0904	
9.	Lamar, CA	Loop		7.0-4	4W1	Cable	CMC	-13					0908	
10.	Mounds, OK	Loop		2.9-3	4W1	Cable	CMC	-13					0912	
11.	Melbourne, FL	One-Way (FD)	1.5-3	8.0-3	4W1	Cable	CMC	-10					0915	
12.	Melbourne, FL	One-Way (FD)	1.9-3	3.2-3	4W1	Cable	CMC	-10						
13.	Melbourne, FL	One-Way (FD)	1.5-3	3.7-3	4W1	Cable	CMC	-13						
14.	Melbourne, FL	One-Way (FD)	1.2-3	7.8-4	4W1	Cable	CMC	-13					0920	
15.	Melbourne, FL	One-Way (FD)	1.7-3	7.8-4	4W1	Cable	CMC	-13					0933	
16.	Melbourne, FL	One-Way (FD)	1.6-3	1.8-3	4W1	Cable	CMC	-13					0934	
17.	Melbourne, FL	One-Way (FD)	4.4-3	3.6-3	4W1	Cable	CMC	-13					0940	
18.	Melbourne, FL	One-Way (FD)	-	7.9-3	4W1	Cable	CMC	-13		-			0946	
19.	Melbourne, FL	One-Way (FD)	3.2-1	6.3-3	4W1	Cable	CMC	-13					0952	

Tests from Cheyenne Mt AFB - 17 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
20.	Melbourne, FL	One-Way (FD)	3.6-2	2.7-3	4W1	Cable	CMC	-13						1004
		One-Way (HD)	3.8-3	2.9-3	4W1	Cable	CMC	-13						1010
21.	Lamar, CO	Loop		0	Lamar Trunk 1	L	LAM	-13						1016
22.	Polk City, FL	Loop		1.6-3	Lamar Trunk 1	L	LAM	-13						1022
23.	Mounds, OK	Loop		1.2-4	Lamar Trunk 1	L	LAM	-13						1028
24.	Memphis Junct., AK	Loop		4.8-3	Lamar Trunk 1	L	LAM	-13						1034
25.	Brewton, AL	Loop		7.8-3	Lamar Trunk 1	L	LAM	-13						1040
26.	Fredericton, NB	Loop		2.9-2	Lamar Trunk 1	L	LAM	-13						1046
27.	Lamar, CO	Loop		1.2-4	Fairview Trunk 1	L	FVW	-13						1052
28.	Polk City, FL	Loop		9.2-4	Fairview Trunk 1	L	FVW	-13						1058
29.	Fredericton, NB	Loop		4.9-3	Fairview Trunk 1	L	FVW	-13						1104
30.	Mounds, OK	Loop		0	Mounds Trunk 1	R	MOV	-13						1106
31.	Polk City, FL	Loop		8.8-3	Mounds Trunk 1	R	MOV	-13						1108
32.	Fredericton, NB	Loop		9.4-3	Mounds Trunk 1	R	MOV	-13						1110
33.	Socorra, NM	Loop		0	Socorra Trunk 1	R	SOC	-13						1117
34.	Polk City, FL	Loop		3.1-4	Socorra Trunk 1	R	SOC	-13						1120
35.	Fredericton, NB	Loop		2.2-2	Socorra Trunk 1	R	SOC	-13						1122
36	Melbourne, FL	One-Way (FD)	2.0-3	2.3-4	Lamar Trunk 1	L	LAM	-13						1124
37.	Melbourne, FL	One-Way (FD)	1.9-4	7.7-4	Lamar Trunk 1	L	LAM	-13						1126
38.	Melbourne, FL	One-Way (FD)	3.8-4	1.2-3	Lamar Trunk 1	L	LAM	-13						1128

Tests from Cheyenne Mt AFB - 17 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
39.	Melbourne, FL	One-Way (FD)	2.5-4	9.1-4	Lamar Trunk 1	L	LAM	-13						1130
40.	Melbourne, FL	One-Way (FD)	1.4-4	9.1-4	Lamar Trunk 1	L	LAM	-13						1132
41.	Melbourne, FL	One-Way (FD)	2.3-3	1.6-3	Fairview Trunk 1	L	FVW	-13						1134
42.	Melbourne, FL	One-Way (FD)	2.1-4	7.0-5	Fairview Trunk 1	L	FVW	-13						1137
43.	Melbourne, FL	One-Way (FD)	7.9-4	3.5-4	Mounds Trunk 1	R	MOJ	-13						1139
44.	Melbourne, FL	One-Way (FD)	2.5-3	8.8-4	Mounds Trunk 1	R	MOJ	-13						1141
45.	Melbourne, FL	One-Way (FD)	6.6-4	2.0-4	Socorra Trunk 1	R	SOC	-13						1143
46.	Melbourne, FL	One-Way (FD)	2.7-4	2.4-4	Socorra Trunk 1	R	SOC	-13						1145
47.	Melbourne, FL	DT-SLO	8.6-3	1.4-3	Socorra Trunk 1	R	SOC	-13						1147
48.	Melbourne, FL	DT-ARL	2.7-3	2.3-3	Socorra Trunk 1	R	SOC	-13						1150
49.	Melbourne, FL	DT-YAK	1.7-2	8.4-2	Socorra Trunk 1	R	SOC	-13						1153
		(Re-Sync)	1.7-2	4.3-2	Socorra Trunk 1	R	SOC	-13						1156
		(Re-Sync)		2.9-2	Socorra Trunk 1	R	SOC	-13						1159
50.	Melbourne, FL	DT-YAK	1.9-2	1.7-2	Socorra Trunk 1	R	SOC	-13						1202
51.	Yakima, WA	Loop		1.4-3	Socorra Trunk 1	R	SOC	-13						1205
52.	Melbourne, FL	One-Way (HD)	2.2-2	2.4-2	DDD (2W)	-	-	-13						1425
53.	Melbourne, FL	One-Way (HD)	2.8-2	3.0-1	DDD (2W)	-	-	-13						1437

Tests from Cheyenne Mt AFB - 17 March (Continued)

To	Type	Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
	One-Way (HD)		9.3-2	DDD (2W)	-	-	-19						
54. Polk City, FL	Loop		1.4-2	4W1	Cable	CMC	-13	-5					1500
			2.0-2	4W1	Cable	CMC	-16	-8					
			1.9-2	4W1	Cable	CMC	-19	-12					
55. Polk City, FL	Loop		1.1-2	4W1	Cable	CMC	-19	-10					1510
56. Yakima, WA	Loop		4.2-3	4W1	Cable	CMC	-19	-13					1513
57. Lamar, CA	Loop		2.6-4	4W1	Cable	CMC	-19	-11					1516

Notes:

1. Calls 1-20 and 52-57 were placed on a 4-wire line at the AutoSevoCom Switch.
2. Calls 21-51 were placed on IST circuits at the ATT facility for the CMC Switch.
3. Call Number 19 indicates error rate after second sync for full duplex mode.

Tests from McChord AFB - 18, 19-20 March

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
1.	Melbourne, FL (OB-Tacoma)	One-Way (HD)		9.1-2	DDD-2W	-	-	-13	-23	6°	28	41	30	0940
		Resync		7.4-2										
		Resync		8.5-2							March 18			
		Resync	1.2-2	8.0-2										
		Resync		7.4-2										
2.	Melbourne, FL (OB-Tacoma)	One-Way (HD)	8.0-3	5.6-2	DDD-2W	-	-	-13	-25	6°	30	44	30	0845
		Resync Sync		6.4-2										
3.	Melbourne, FL (OB-Tacoma)	One-Way (HD)	-	4.9-2	DDD-2W	-	-	-13						0850
4.	Melbourne, FL (OB-Tacoma)	One-Way (HD)	1.6-3	3.8-2	DDD-2W	-	-	-13						0900
5.	Melbourne, FL (OB-Port Angeles)	One-Way (HD)	6.0-3	1.5-2	DDD-2W	-	-	-21						0846
		Resync		1.2-2										
6.	Melbourne, FL (OB-Port Angeles)	One-Way (HD)		1.1-1	DDD-2W	-	-	-21			March 19			0851
			1.2-4	1.0-3				-15						
7.	Melbourne, FL (OB-Port Angeles)	One-Way (HD)	3.8-4	7.2-4	DDD-2W	-	-	-15						0856
8.	Melbourne, FL (OB-Port Angeles)	One-Way (HD)	2.5-4	6.5-4	DDD-2W	-	-	-15	-30	5°	31	41	44	0901

Tests from McChord AFB - 18, 19-20 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
9.	North Bend, WA	Loop		0	AV1	LI	NBD	-13	-9		(54.57 miles)			0830
10.	Polk City, FL	Loop		1.9-3	AV1	LI	NBD	-13	-16					0845
11.	Arlington, VA	Loop		7.0-4	AV1	LI	NBD	-13	-16					0900
12.	Mt. Livingston, WA	Loop		8.4-4	Number 1	ON2(155.31 miles)		-13	-8					0930
13.	Billingham, WA	Loop		1.4-2	Number 2	ON2(151.63		-13	-9	5°	38	38	27	0945
				5.1-3	Number 2	ON2	-	-19	-19			39	29	
				7.4-3	Number 2	ON2	-	-16	-14					
14.	Melbcurne, FL	One-Way (FD)	2.1-1	1.3-1	AV1	LI	NBD	-13	-20					1000
		One-Way (HD)	1.2-4	8.8-4	AV1	LI	NBD	-13	-13					
		One-Way (HD)	1.0-3	1.3-3	AV1	LI	NBD	-13	-13					
15.	Seattle, WA	Loop		3.2-2 2.6-2	Number 3	BN (63.38 miles)	-13	-14 -23	1°		26	24	0	1020
16.	Tacoma, WA	Loop		3.1-2 5.5-3	Number 4	NI (31.26 miles)	-13	-11 -23	2°		24 30	29 30	26	1040
17.	Seattle, WA	Loop		6.7-3 1.8-3	Number 5	NI (63.38 miles)	-13	-12 -23	1°		34 36	30 30	30	1105
18.	Yakima, WA	Loop		0	AV1	LI	NBD	-13	-17					1120
19.	Lyons, NE	Loop		1.0-2	AV1	LI	NBD	-13	-16					1122
20.	CMC, CO	Loop		3.2-3	AV1	LI	NBD	-13	-16					1124
21.	Lamar, CO	Loop		7.8-3	AV1	LI	NBD	-13	-14					1126
22.	Mounds, OK	Loop		2.7-3	AV1	LI	NBD	-13	-13					1128
23.	Memphis Junct., AR	Loop		5.6-3	AV1	LI	NBD	-13	-16					1131
24.	Jasper, AL	Loop		5.3-3	AV1	LI	NBD	-13	-21					1134
25.	Brewton, AL	Loop		2.4-2	AV1	LI	NBD	-13	-12	8°	26	35	32	1138

Tests from McChord AFB - 18, 19-20 March (Continued)

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
26.	Helena, MT	Loop		4.5-4	AV1	LI	NBD	-13	-13					1142
27.	Fredericton, NB	Loop		2.3-2	AV1	LI	NBD	-13						1145
28.	Fredericton, NB	Loop		3.7-3	AV1	LI	NBD	-13	-17					1147
29.	Brewton, AL	Loop		1.7-2	AV1	LI	NBD	-13						1150
30.	Melbourne, FL	One-Way (FD)	4.2-3	1.4-3	AV1	LI	NBD							1310
31.	Melbourne, FL	One-Way (HD)	4.2-3	1.0-3	AV1	LI	NBD	-13	-12					
		One-Way (FD)		1.5-3	AV1	LI	NBD	-13	-16					
32.	Melbourne, FL	One-Way (HD)	2.5-4	4.5-3	AV1	LI	NBD	-13						1320
33.	Melbourne, FL	One-Way (HD)	2.1-3	3.5-4	AV1	LI	NBD	-13						1330
34.	Melbourne, FL	One-Way (HD)	5.0-4	2.0-3	AV1	LI	NBD	-13	-16					1337
35.	Melbourne, FL	One-Way (HD)	2.2-2	1.7-4	AV1	LI	NBD	-13	-15					1345
36.	Melbourne, FL	One-Way (HD)	1.7-2	1.4-3	(2W-AV)	LI	NBD	-13						1355
37.	Melbourne, FL	One-Way (HD)	5.5-2	8.0-2	(2W-DDD)	-	-	-13	-30	6C	31	41	38	1405

Notes
1) Calls 1-4 were placed from an offsite location in Tacoma, Washington.
2) Calls 1-4 displayed reflection characteristics.
3) Calls 5-8 were placed from an offsite location in Port Angeles, Washington.
4) Call 37 displayed reflection characteristics.
5) Calls 9-37 were placed from the ATT Test Facilities at McChord.

Tests from Vandenberg AFB - 21 March

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
1.	Melbourne, FL	One-Way (OB)		1.8-3	(2W-DDD)	-	-	-15						0630
2.	Melbourne, FL	One-Way (OB)		1.0-2	(2W-DDD)	-	-	-15	-22					
				3.3-3	(2W-DDD)	-	-	-21	-28					0640
3.	Melbourne, FL	One-Way (OB)		5.2-3	(2W-DDD)	-	-	-21	-33					
				7.1-4				-15	-27					0650
4.	San Luis Obispo, CA	Loop		9.1-3	002 LMX-ON	Cable-	SLO	-19	-12	0°	30	40	24	1026
				9.3-3	002 LMX-ON	Cable-	SLO	-13	-6					
5.	Mojave, CA	Loop		4.5-2	002 LMX-ON	Cable-	SLO	-13	-6	7°	29	32	21	1036
				4.0-2				-19						
6.	Sweetwater, TX	Loop		1.8-2	002 LMX-ON	Cable-	SLO	-13	-8					1046
				1.9-2				-19						
7.	Memphis Junct. AK	Loop		5.8-2	002 LMX-ON	Cable-	SLO	-13						1056
				5.6-2				-19	-6	7°	28	45	22	1106
8.	Polk City, FL	Loop		3.9-2	002 LMX-ON	Cable-	SLO	-13						1116
9.	Arlington, VA	Loop		6.4-2	002 LMX-ON	Cable-	SLO	-13	-5					1126
10.	Fredericton, NB	Loop		7.3-2	002 LMX-ON	Cable-	SLO	-13	-1					1145

Tests from Vandenberg AFB - 21 March (Continued)

To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
11. Melbourne, FL	One-Way (FD)	1.0-2	1.9-1	002	Cable-LMX-ON	SLO	-13	-9					1156
	One-Way (HD)		1.2-3				-13	-11					
	One-Way (FD)		1.7-3				-13	-10					
12. Melbourne, FL	One-Way (FD)	7.8-2	4.1-2	002	Cable-LMX-ON	SLO	-13	-13			43		1207
	One-Way (HD)	1.1-2	2.1-3				-13	-13					
	One-Way (FD)	4.3-2					-13	-13					
13. Melbourne, FL	One-Way (FD)	2.2-2	5.6-3	002	Cable LMX-ON	SLO	-13	-11					1218
	One-Way (HD)	2.2-2	5.1-3				-13	-10					
14. Melbourne, Fl	One-Way (FD)		3.2-3	005	Cable-LMX-N2	SLO	-13	-13					1229
	One-Way (HD)	3.4-2	3.2-3				-13						
15. Melbourne, FL	One-Way (FD)		4.1-3	005	Cable-LMX-N2	SLO	-13	-13					1240
	One-Way (HD)	7.2-3	6.2-3				-13	-13					
16. Melbourne, FL	One-Way (FD)		5.0-3	005	Cable-LMX-N2	SLO	-13	-15					1300
	One-Way (HD)	8.5-2	4.8-3										

Tests from Vandenberg AFB - 21 March (Continued)

	To	Type	BER Mlb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
17.	San Luis Obispo, CA	Loop		4.7-3	005 LMX-N2	Cable-	SLO	-13	-13					1418
18.	Mojave, CA	Loop		1.1-2	005 LMX-N2	Cable-	SLO	-13	-13					1423
19.	Sweetwater, TX	Loop		1.5-2	005 LMX-N2	Cable-	SLO	-13	-17					1428
20.	Memphis Junct. AK	Loop		2.8-2	005 LMX-N2	Cable-	SLO	-13	-15					1433
21.	Polk City, FL	Loop		1.9-2	005 LMX-N2	Cable-	SLO	-13	- 9					1438
22.	Arlington, VA	Loop		2.2-2	005 LMX-N2	Cable-	SLO	-13	-10					1443
23.	Fredericton, NB	Loop		3.9-2	005 LMX-N2	Cable-	SLO	-13	- 8					1448
24.	Lyons, NE	Loop		3.4-2	005 LMX-N2	Cable-	SLO	-13						1453
25.	Yakima, WA	Loop		3.3-2	005 LMX-N2	Cable-	SLO	-13						1458
26.	North Bend, WA	Loop		6.5-2	005 LMX-N2	Cable-	SLO	-13						1503
27.	Julian, CA	Loop		1.3-2	005 LMX-N2	Cable-	SLO	-13	-13					1508
28.	Santa Maria, CA	Loop		0	-	TI-D3	-	-13	-10	1°	35	54	47	1530
29.	Melbourne, FL	One-Way (HD)		2.4-1	2W-DDD	-	-	-13	-15	4°	30	31	33	1543

Notes:

1) Tests 1-3 were conducted at an offsite location in Santa Maria, CA.
2) The remaining tests were conducted at the GTE Test Facility at Vandenberg.
3) Test 12 evidenced "breathing" when a 1 kHz tone was sent full duplex. The "breathing" stopped in the simplex configuration.

Tests from March AFB - 22 March

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
1.	Melbourne, FL	One-Way (FD)	3.0-3	1.2-3	003(M)	Cable-LMX-R	MOJ	-13	-11					1043
2.	Melbourne, FL	One-Way (FD)		3.3-3	003(M)	Cable-LMX-R	MOJ	-13	- 9					1048
		One-Way (HD)	1.1-3	3.0-3				-13						
3.	Melbourne, FL	One-Way (FD)		1.1-1	003(M)	Cable-LMX-R	MOJ	-13	-12	12°	26	40	40	1058
		One-Way (HD)	1.6-3	1.1-1				-13	-10					
4.	Melbourne, FL	One-Way (FD)	6.0-3	4.7-3	003(M)	Cable-LMX-R	MOJ	-13	-10					1105
5.	Melbourne, FL	One-Way (FD)		7.8-3	003(J)	Cable-LMXR	JUL	-13	-10					1110
		One-Way (HD)	1.1-2	6.9-3				-13	-10					
6.	Melbourne, FL	One-Way (FD)		1.4-2	003(J)	Cable-LMX-R	JUL	-13	-10		28	40	30	1115
		One-Way (HD)	8.6-3	1.3-2				-13	-10					
7.	Melbourne, FL	One-Way (FD)	1.2-4	2.8-3	(2W-AV)	-	-	-13	-18					1133
8.	Melbourne, FL	One-Way (HD)	1.1-3	6.8-3	(2W-AV)	-	-	-13	-18					1143
9.	Melbourne, FL	One-Way (HD)	3.5-3	4.6-2	2W-DDD	TI	-	-13	-18					1153
		Re-Sync		1.3-2				-19	-21					
		One-Way (HD)		3.6-2				- 7	- 8					
		One-Way (HD)		1.2-1										

Tests from March AFB - 22 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
10.	Melbourne, FL	One-Way (HD)	5.2-3	3.1-2	2W-DDD	TI	-	-13	-21					1203
11.	Melbourne, FL	One-Way (HD)	9.9-3	3.0-3	2W-AV	9Mi Base-Cable-AV	?	-13	-24					1400
12.	Melbourne, FL	One-Way (HD)	4.3-3	6.6-3	2W-AV	9Mi Base-Cable-AV	?		-25					1405
13.	Melbourne, FL	One-Way (HD)	3.0-3	3.7-3	2W-AV	9Mi Base-Cable-AV	?		-25					1410
14.	Melbourne, FL	One-Way (HD)	1.2-2	9.2-3	2W-DDD	9Mi Base-Cable-TI	-	-13	-23					1415
		Re-Sync		1.8-2										
		Re-Sync		2.1-2										
15.	Melbourne, FL	One-Way (HD)	-	7.5-3	2W-DDD	9Mi Base-Cable-TI	-	-13	-23					1425
		Re-Sync		1.4-2										
16.	Melbourne, FL	One-Way (HD)	2.9-2	2.1-2	2W-DDD	9Mi Base-Cable-TI	-	-13	-22					1435
17.	Mojave, CA	Loop		9.0-5	202(M)	Cable-LMX-R	MOJ	-13	-11					1439
18.	Polk City, FL	Loop		1.4-2	202(M)	Cable-LMX-R	MOJ	-13	- 9					1444
19.	Arlington, VA	Loop		4.6-3	202(M)	Cable-LMX-R	MOJ	-13	-11					1449
20.	North Bend, WA	Loop		8.6-4	202(M)	Cable-LMX-R	MOJ	-13	-12					1454
21.	Yakima, WA	Loop		2.2-2	202(M)	Cable-LMX-R	MOJ	-13	-12					1459

Tests from March AFB - 22 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
22.	Lyons, NE	Loop		2.1-2	002(M)	Cable-LMX-R	MOJ	-13	-10					1504
23.	CMC, CO	Loop		3.5-2	002(M)	Cable-LMX-R	MOJ	-13	-14					1509
24.	Hagerstown, MD	Loop		5.3-2	002(M)	Cable-LMX-R	MOJ	-13	- 9					1514
25.	Fredericton, NB	Loop		2.0-2	002(M)	Cable-LMX-N2	MOJ	-13	- 7					1519
26.	Sherbrooke, PQ	Loop		8.1-2	002(M)	Cable-LMX-N2	MOJ	-13						1524
27.	Dover Foxcroft,	Loop MNE		2.9-2	002(M)	Cable-LMX-N2	MOJ	-13	- 9					1529
28.	Smith Falls, ON	Loop		6.7-2	002(M)	Cable-LMX-N2	MOJ	-13	- 7					1534
29.	Chester-field, MA	Loop		1.4-2	002(M)	Cable-LMX-N2	MOJ	-13						1539
30.	Tulley, NY	Loop		2.3-2	002(M)	Cable-LMX-N2	MOJ	-13	- 7					1543
31.	Wyoming, MN	Loop		1.6-2	002(M)	Cable-LMX-N2	MOJ	-13						1547
32.	Mojave, CA	Loop		2.6-4	005(M)	Cable-LMX N2	MOJ	-13	- 8					1551
33.	Polk City, FL	Loop		1.6-2	005(M)	Cable-LMX-N2	MOJ	-13	- 9					1555
34.	Arlington, VA	Loop		6.0-3	005(M)	Cable-LMX-N2	MOJ	-13	-11					1559
35.	Polk City, FL	Loop		3.6-2	SVC Number 2	-	JUL	-13	-13					1603
36.	Julian, CA	Loop		3.0-5	SVC Number 2	-	JUL	-13	-16					1607
37.	Arlington, VA	Loop		7.9-3	SVC Number 2	-	JUL	-13	-17					1611
38.	North Bend, WA	Loop		4.2-3	SVC Number 2	-	JUL	-13	-16					1615

Tests from March AFB - 22 March (Continued)

To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
39. Melbourne, FL (OB)	One-Way (HD)		1.1-1	(2W-DDD)	-	-	-13	-23	7°	30	42	31	0837
	One-Way (HD)		1.0-1		March 23		-19	-28					
40. Melbourne, FL	One-Way (HD)	2.8-2	4.7-2	(2W-DDD)	-	-	-13	-20			41	35	0855
	Re-Sync		3.9-2										
41. Melbourne, FL	One-Way (HD)	4.2-3	1.0-1	(2W-DDD)	-	-	-13	-24	6°	22	29	23	0905

Notes:

1) Calls 1-10 and 17-38 were placed at the GTE Test Facilities at March.
2) Calls 11-16 were placed at the command post which has 9 miles of Air Force cable to the PBX.
3) Calls 39-41 were placed at an offsite location in Riverside, CA.

Tests from McDill AFB - 24 March

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
1.	Melbourne, FL	One-Way (HD)	-	3.2-3	2W-DDD	-	-	-13	-22					0913
2.	Melbourne, FL	One-Way (HD)	-	5.4-4	2W-DDD	-	-	-13	-22					0915
3.	Melbourne, FL	One-Way (HD)	1.9-3	4.7-4	2W-DDD	-	-	-13	-23					0930
4.	Polk City, FL	Loop		0	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-19					1100
5.	Arlington, VA	Loop		3.3-4	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-18					1110
6.	Hagerstown, MD	Loop		1.4-2	9GP-1004-001	Unloaded) 5 Miles Cable-LMX	POL	-15	-16					1115
7.	Lyons, NE	Loop		5.7-3	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-18					1118
8.	CMC, CO	Loop		7.7-3	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-16					1120
9.	North Bend, WA	Loop		3.0-2	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-18					1122
10.	Julian, CA	Loop		6.7-3	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-20					1124
11.	Mojave, CA	Loop		1.2-2	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-20					1128

Tests from McDill AFB - 24 March (Continued)

	To	Type	BER Melb	Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
12.	San Luis Obispo, CA	Loop		1.8-3	9GP-1004-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-19					1132
13.	Polk City, FL	Loop		-	9GP-1006-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-19					1135
14.	Arlington, VA	Loop		5.8-4	9GP-1006-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-19					1138
15.	North Bend, WA	Loop		4.3-2	9GP-1006-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-21					1141
16.	Yakima, WA	Loop		1.1-2	9GP-1006-001	(Unloaded) 5 Miles Cable-LMX	POL	-15	-15					1144
17.	Polk City, FL	Loop		5.8-4	9GP-30820-002	(Unloaded) 5 Miles LMX-LMX-POL JAX	ELL	-15	-13					1148
18.	Ellisville, FL	Loop		0.3-4	9GP-30820-002	(Unloaded) 5 Miles LMX-LMX-POL JAX	ELL	-15	-14					1152
19.	Arlington, VA	Loop		2.1-3	9GP-30820-002	(Unloaded) 5 Miles LMX-LMX-POL JAX	ELL	-15	-13					1156

Tests from McDill AFB - 24 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
20.	Yakima, WA	Loop		2.7-2	9GP-30820-002	(Unloaded) 5 Miles Cable-LMX LMX-POL-JAX	ELL	-15	-18					1200
21.	Fredericton, NB	Loop		3.8-2	9GP-30920-002	(Unloaded) 5 Miles Cable-LMX LMX-POL-JAX	ELL	-15	-10					1204
22.	Polk City, FL	Loop		-	9GP-10227-001	22H88-LMX-Tampa-LMX-POL	POL	-15	-23					1208
23.	Arlington, VA	Loop		1.1-4	9GP-10227-001	22H88-LMX-Tampa-LMX-POL	POL	-15	-23					1212
24.	North Bend, WA	Loop		8.6-2	9GP-10227-001	22H88-LMX-Tampa-LMX-POL	POL	-15	-20					1216
25.	Yakima, WA	Loop		3.2-2	9GP-10227-001	22H88-LMX-Tampa-LMX-POL	POL	-15	-24					1270
26.	Julian, CA	Loop		9.1-3	9GP-10227-001	22H88-LMX-Tampa-LMX-POL	POL	-15						1222
27.	Melbourne, FL	One-Way (FD)	3.1-4	2.0-5	9GP-1004-001	Cable-LMX	POL	-15						1335
28.	Melbourne, FL	One-Way (FD)	1.2-4	3.0-5	9GP-1006-001	Cable-LMX	POL	-15						1343
29.	Melbourne, FL	One-Way (FD)	-	0	9GP-10227-001	Cable-LMX	POL	-15						1345

Tests from McDill AFB - 24 March (Continued)

	To	Type	BER Melb	BER Site	Access Line	Access Type	Switch	XMT Sig	RCV Sig	Phase Jitt.	S/N	Harm. Dist. 2nd	Harm. Dist. 3rd	Time
30.	Melbourne, FL	One-Way (FD)		2.0-5	9GP-10227-001	Cable-LMX	POL	-15						1347
31.	Melbourne, FL	One-Way (FD)	6.9-4	1.3-5	9GP-30820-002	Cable-LMX-LMX	ELL	-15						1355
32.	Melbourne, FL	DT-YAK (FD)	9.4-2	4.1-2	30820-002	Cable-LMX-LMX	ELL	-15	-16					1400
		Re-Sync (FD)		2.3-2	30820-002	Cable-LMX-LMX	ELL	-15	-17					1405
33.	Melbourne, FL	DT-JAS -MOS-DRA(FD)	2.1-2	2.1-2	30820-002	Cable-LMX-LMX	ELL	-15	-17					1410
		(HD)		2.4-2	30820-002	Cable-LMX-LMX	ELL							
34.	Melbourne, FL	One-Way (HD)	2.5-4	1.7-3	(2W-AV)	-	-	-13	-17					1420
35.	Melbourne, FL	One-Way (HD)	5.0-4	2.8-4	2W-DDD	-	-	-13	-32					1430
36.	Melbourne, FL	One-Way (HD)	6.2-4	5.1-3	2W-DDD	-	-	-13	-30					1435
37.	Ellisville, FL	Loop		1.0-4	9GP-30819-001 (SVC)	Cable-LMX-LMX	ELL	-13	-21					1445
38.	Arlington, VA	Loop		4.8-3	9GP-30819-001 (SVC)	Cable-LMX-LMX	ELL	-13	-23					1452
39.	Julian, CA	Loop		5.3-2	9GP-30819-001 (SVC)	Cable-LMX-LMX	ELL	-13						1455
		Re-Sync		3.6-2										

Notes:

1) Calls 1-3 placed from offsite location in Tampa. Error on Calls 1-3 and Call 41 have transient error rate condition.
2) All other calls placed from GTE facilities at McDill.

APPENDIX C

PHASE II DATA

APPENDIX C

PHASE II DATA

This Appendix presents the data gathered during Phase II of the test program. The Appendix contains seven tables. Tables C-1, C-2, C-3 and C-4 present the BER values achieved. Table C-5 presents line characteristic .ta. Table C-6 presents information on the access lines used during the calls. Table C-7 presents pictures of amplitude and delay distortion on calls in which the data was gathered.

C.1 Data on BER

Table C-1 presents BER data on calls from MacDill to the Pentagon. Table C-2 presents BER data on call from Offut to the Pentagon. Table C-3 presents BER data on calls from March to Melbourne, the Pentagon, and Ft. Meade. Table C-4 presents data on looped calls from the Pentagon, MacDill, Offut, March and Ft. Meade. The numbering of the call indicates the date of the call and the end originating the call. The letter indicates the call originator. The letter "A" indicates a call originated at the Washington end (the Pentagon or Ft. Meade). The letter "B" indicates a call originating from the remote end (MacDill, Offut or March). The letter "H" indicates a call originating from the Harris plant in Melbourne. The last two numbers indicate the date of the call in April, 1978. The looped calls use the letter "D" for MacDill, "M" for March, "N" for Ft. Meade, and "O" for Offut.

The BER values are listed for 16, 8 and 9.6 Kb/s on calls where the corresponding BER value was recorded. The type of call is listed as:

2 WAV - Two-wire Autovon calls

2 W Loop - Two-wire looped call

2 WDT - Two-wire dial-through call

4 WSV - Four-wire Autosevocom call

SVDT - Autosevocom dial-through call

DL - Digital loop

AL - Analog loop

The data recorded under Number of Syncs indicates the number of syncs tried and the number of successful syncs. As can be seen, most calls involved two tries and two successes. The sync tries on each connection are entered in calls where two connections were involved. The column labeled Information indicates whether or not access line information is recorded in Table C-6. An asterisk indicates that the call is included in Table C-6. The column headed as Line Measure indicates whether or not line measurement information is included in Table C-5. The letter "A" indicates that the information was recorded at the Washington area site and is included in Part A of Table C-5. The letter "B" indicates that the information was recorded at the remote site and is included in Part B of the table. The letters "AB" indicate that the data was recorded at both locations and appears under that call number in both parts of the table. The column "Amp. and Delay" indicates those calls with a picture of amplitude response and delay distortion included in Table C-7. The letter "A and B" indicate the location where the data was recorded as in the line measure column.

C.2 Line Measurements

Table C-5 lists the line measurement data taken with the Halcyon. The meaning of the column headings are:

RCV-Sig - the received data level in dBm0

S/N - Ratio of RCVSig to quiet line noise level

Tone - the received 1 kHz tone level in dBm0

T/N - Ratio of tone to notched noise level

Offset - the frequency offset in Hz

2ND and 3RD Harmonic Distortion - the Levels of second and third harmonic distortion in dBm below the signal level (as determined from the 4-tone test of the Halcyon)

PJ - Peak-to-peak phase jitter in degrees

Hits - The number of hits in 5 minutes

± 3 dB - three dB amplitude hits

$\pm 20^{\circ}$ - twenty degree phase hits

71, 75, 79 - Number of impulses exceeding 71, 75 and 79 dBrn

D.O. - Drop out

It should be noted that S/N ratio and T/N ratio differ in two ways. The T/N ratio contains harmonic distortion components not present in the S/N ratio which often causes it to be lower than the S/N ratio. However, the received signal level does not always correspond to the level of received one kHz tone due to frequency response variations. This can cause the T/N to be higher than the S/N ratio as well as lower.

C.3 Access Line Information

Table C-6 lists the calls in which additional access line information was recorded. The table lists the originating and terminal location of the call, the local Autovon switches involved and the recorded information as to the numbering on the access line. In the comments column, additional information relative to the call or access line type is given.

C.4 Amplitude and Delay Distortion Data

Table C-7 presents the picture of amplitude and delay distortion data along with the call number listed in Table C-1, C-2, C-3 or C-4. The letter "A" or "B" following the call number indicates whether the data was recorded at the Washington area end (A) or the remote end (B). In cases of looped calls, A1 and A2 or B1 and B2 are used to indicate the two connections involved when measurements were made on both connections.

Table C-1. MacDill-Pentagon

Call Number	(EST) Time	BER at MacDill 16 kb/s	BER at MacDill 8 kb/s	BER at MacDill 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	Number of Sync	Access Info	Line Meas	Amp and Delay
1B03	1630	2.2-3						2WAV	2/2, -			
2B03	1820	3.6-2		1.1-4	2.6-2			2WDT(JAS-NOR-MOS)	3/4, 2/2		AB	AB
	1846	2.2-2										
1A04	0820	1.9-3			8.2-4			2WAV	2/2, 2/2			
2A04	0825	2.2-3			1.8-4			2WAV	2/2, 2/2			
3B04	0840	2.1-3			5.0-4				2/2, 2/2			
4A04	0850	3.1-3			3.0-4			2WAV	3/4, 2/2			
5B04	0905	2.8-3			6.9-4			2WAV	2/2, 2/2			
6A04	0915	2.7-3			7.8-4			2WAV	2/2, 2/2			
7A04	0920	7.1-2			-			2WAV	2/2, -		B	
8B04	0943	3.5-			1.2-3			2WAV	2/2, 2/2			
9B04	0950	4.2-2	1.0-5		-			2WAV	2/2, -		B	
10B04	1045	9.8-3			3.6-3			2WAV	2/2, 2/2		A	
	1050	3.2-3										
11B04	1100	3.5-2			-			2WAV	2/2, -			

Table C-1. MacDill-Pentagon (Continued)

Call Number	(EST) Time	BER at MacDill 16 kb/s	BER at MacDill 8 kb/s	BER at MacDill 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	Number of Sync	Access Info	Line Meas	Amp and Delay
12B04	1110	3.1-2	1.0-1	9.4-5	-			2WAV	2/2, -		B	B
13B04	1250	6.0-4			1.0-3			2WAV	2/2, 2/2			
14B04	1255	2.1-5			1.2-3			2WAV	2/2, 2/2			
15B04	1305	4.6-4			9.9-4			2WAV	2/2, 2/2			
16B04	1310	3.2-4			5.8-4			2WAV	2/2, 2/2			
17B04	1314	1.0-3			3.2-4			2WAV	2/2, 2/2			
18B04	1317	4.8-3			4.7-4			2WAV	3/4, 2/2			
19B04	1322	2.0-3			9.0-5			2WAV	2/2, 2/2			
20B04	1332	-			3.7-4			2WAV	- , 2/2			
21B04	1340	2.7-3			1.9-3			2WAV	2/5, 2/2			
22B04	1350	2.7-3			2.2-3			2WAV	2/2, 2/2			
23B04	1405	2.9-4			2.3-4			2WAV	2/2, 2/2			
24B04	1408	2.5-3			5.0-4			2WAV	2/2, 2/2			
25B04	1413	2.0-3			5.3-3			2WAV	2/2, 2/2			
26B04	1415	1.6-2		2.1-5	8.5-4			2WAV	2/2, 2/2		B	B

Table C-1. MacDill-Pentagon (Continued)

Call Number	(EST) Time	BER at MacDill 16 kb/s	BER at MacDill 8 kb/s	BER at MacDill 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	Number of Sync	Access Info	Line Meas	Amp and Delay
27B04	1440	2.0-4			1.7-4			2WAV	2/2, 2/2			
28B04	1500	9.7-4			3.5-4			2WAV	2/2, 2/2			
29B04	1505	2.6-3			1.2-2	0	1.5-4	2WAV	2/2, 2/2		A	A
30B04	1548	1.2-2			-			2WAV	2/3, -			
31B04	1558	4.0-3		7.3-5	2.0-4			2WAV	3/4, 2/2	*	B	B
	1640	1.0-2						2WAV				
32B04	1647	1.2-4			6.5-4			2WAV	2/2, 2/2	*		
33B04	1655	7.3-4			8.4-4			2WAV	2/2, 2/2	*		
34B04	1658	1.2-2			7.0-4			2WAV	2/2, 2/2	*		
35B04	1705	2.1-1			5.4-3			2WAV	2/2, 2/2	*	B	B
36B04	1802	2.6-2	6.3-2		8.1-4			2WAV	2/2, 2/2			
37B04	1809	4.1-3			9.8-4			2WAV	2/2, 2/2			
1B05	0820	4.7-3			3.5-3			2WDT(JAS)	2/2, 2/2			
2B05	0840	-			1.2-2			2WAV	- , 2/2		A	
3B05	0850	3.5-2	0		9.4-3			2WDT(SEG-JAS)	2/2, 2/2		B	B

Table C-1. MacDill-Pentagon (Continued)

Call Number	(EST) Time	BER at MacDill 16 kb/s	BER at MacDill 8 kb/s	BER at MacDill 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	Number of Sync	Access Info	Line Meas	Amp and Delay
4B05	0956	1.3-1	8.0-5	2.5-4	3.8-2			2WDT(JAS-NOR-MOS)	3/3, 2/2			
5B05	1044	1.1-1	3.2-4	6.2-5	2.6-2			2WDT(JAS)	2/2, 2/2			B
6B05	1412	4.5-3			1.4-3			2WAV	4/4, 2/2			B
7B05	1412	4.3-2	1.0-5	0	8.7-3			2WDT(SEG)	2/3, 2/2		B	B
	1430	1.2-2										
8B05	1531	5.9-2			-			2WDT(SEG-SLO)	1/2, -			
9B05	1556	1.3-1	5.0-5	1.1-4	7.5-3			2WDT(SEG-SLO)	2/2, 2/2		B	B
10B05	1640	1.8-1	2.9-3	1.6-1	7.5-2			2WDT(SEG-SLO-NOR)	3/3, 2/2		AB	AB
11B05	1646	-			3.7-4			2WAV	- , 2/2			
1B06	1345	8.8-4			4.0-3			2WAV	2/2, 2/2	*		
2B06	1355	3.7-2			1.0-4			2WAV	2/2, 2/2	*	B	B
3B06	1425	1.4-1	1.0-4	0	9.5-4			DDD	2/2, 2/2		B	B
4B06	1500	2.7-3			2.0-4			DDD	2/2, 2/2			
5B06	-	1.0-1	0		-0			DDD	2/2, -		B	B
6B06	1530	2.2-1	1.2-4	0	9.0-5			DDD	2/2, 2/2			

Table C-1. MacDill-Pentagon (Continued)

Call Number	(EST) Time	BER at MacDill 16 kb/s	BER at MacDill 8 kb/s	BER at MacDill 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	Number of Sync	Access Info	Line Meas	Amp and Delay
7B06	1540	1.7-1			2.1-4			DDD	2/1, 2/2			
8B06	1612	4.2-2			3.0-4			2WAV	2/2, 2/2	*		
9B06	1619	3.0-3			5.4-4			2WAV	2/2, 2/2	*		
10B06	1633	2.0-1	9.4-3		-			2WAV	2/2, -	*		
1A07	1130	3.9-4			4.4-5			4WSV	2/2, 2/2	*		
2A07	1154	1.9-3			6.2-6			4WSV	2/2, 2/2	*		
3A07	1200	1.9-3			1.2-5			4WSV	2/2, 2/2	*		
		7.5-4			4.5-3			D.L	1/1, 1/1			
		7.1-4			1.3-2			AL	1/1, 1/1			
4A07	1212	7.7-4			0			4WSV	1/1, 2/2	*		
					1.8-4			DL	2/2			
					1.5-3			AL	2/2			
5A07	1225	1.8-3			4.4-5			4WSV	2/2, 2/2	*		
					4.3-2			DL	1/1			
					2.1-2			AL	1/1			

Table C-1. MacDill-Pentagon (Continued)

Call Number	(EST) Time	BER at MacDill 16 kb/s	BER at MacDill 8 kb/s	BER at MacDill 9.6 kb/s	PER at Pentagon 16 kb/s	PER at Pentagon 8 kb/s	PER at Pentagon 9.6 kb/s	Type of Call	Number of Sync	Access Info	Line Meas	Amp and Delay
6A07	1230	1.7-3			1.0-4			4WSV	2/2, 2/2	*		
					1.7-3			DL	1/1			
					1.9-2			AL	1/1			
7A07	1235	1.5-3			1.6-4			4WSV	4/4, 4/4	*		
					1.1-3			DL	1/1			
					2.7-2			AL	1/2			
8A07	1245	1.1-3			1.1-4			4WSV	2/2, 2/2	*		
					2.0-3			DL	1/1			
					2.0-2			AL	1/1			
9A07	1247	2.7-3			1.4-4			4WSV	2/2, 2/2	*		
					1.3-3			DL	1/1			
					2.8-2			AL	1/1			
10A07	1252	7.3-4			1.6-4			4WSV	2/2, 2/2	*	AB	AB
					4.9-4			DL	1/1			
					4.5-2			AL	1/1			

Table C-1. MacDill-Pentag... (Continued)

Call Number	(EST) Time	BER at MacDill 16 kb/s	BER at MacDill 8 kb/s	BER at MacDill 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	Number of Sync	Access Info	Line Meas	Amp and Delay
11A07	1335	6.1-3			7.7-4			SVPT(SEG)	3/5, 2/2	*		
12A07	1342	1.4-2			8.0-3			SVDT(SEC-JAS)	2/2, 2/2	*	B	B
13A07	1349	4.4-2	0	8.3-5	6.2-2	2.5-5	1.0-5	SVDT(SEG-JAS-NOR)	2/2, 2/2	*	A	
14A07	1425	7.0-5			0			4WSV	2/2, 2/2	*		
15A07	1438	3.0-5			6.2-6			4WSV	2/2, 2/2	*		
16A07	1442	7.0-5			2.5-5			4WSV	2/2, 2/2	*		
17A07	1447	7.0-5			0			4WSV	2/2, 2/2	*		
2M07	0930	1.8-1 (6 dB pad at MacDill Rx)						DDD	-			
		1.0-1 (6 dB pad at Pentagon Tx and MacDill Rx)										
		8.5-2 (6 dB pad at Pentagon Tx, 0 dB at Rx)										
		4.0-2 (6 dB pad at Pentagon Tx, 6 dB pad at MacDill Rx - Boosted Power at Pentagon)										
		2.9-4 Same as above - eventually trained to this BER										

Table C-2. Offut-Pentagon

Call No.	EST Time	BER at Offut 16 kb/s	BER at Offut 8 kb/s	BER at Offut 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
1810	1545	5.9-4			3.1-4			2WAV	2/2, 2/2			
2810	1555	2.6-2	3.0-5	0	1.2-2	0	0	2WAV	2/2, 2/2			
3810	1658	2.3-4			2.5-4			2WAV	2/2, 2/2		AB	AB
4810	1706	5.3-4			2.8-4			2WAV	2/2, 2/2			
5810	1711	3.1-3			7.6-3			2WAV	2/2, 2/2			
6810	1720	6.0-5			5.5-4			2WAV	2/2, 2/2			
7810	1725	3.0-5			9.0-5			2WAV	2/3, 2/2			
8A10	1732	1.0-3			3.3-3			2WDT(MOS-NOR)	2/2, 2/2			
7A10	1805	1.4-1	1.2-4	4.9-2	7.1-2	1.4-4	2.4-3	2WDT(JAS-NOR-YAK)	1/1, 2/2		AB	AB
1811	0945	8.7-2	0	2.0-3	2.3-2	9.0-4	1.0-5	2WAV	5/5, 2/2	*	AB	B
	1008	1.5-2						2WAV	2/2, 2/2	*		
2811	1025	1.4-3			2.2-3			2WAV	2/2, 2/2	*		
3811	1035	3.1-3			2.1-3			2WAV	2/2, 2/2	*		
4811	1041	3.2-3			2.7-4			2WAV	2/2, 2/2	*		
5811	1052	5.6-4			2.7-3			2WAV	2/2, 2/2	*		

Table C-2. Offut-Pentagon (Continued)

Call No.	EST Time	BER at Offut 16 kb/s	BER at Offut 8 kb/s	BER at Offut 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
6811	1058	2.2-4			1.2-3			2WAY	2/3, 2/2	*		
7811	1108	1.7-3			6.2-3			2WAY	2/2, 2/2	*		
8811	1112	5.2-4			6.8-4			2WAY	2/2, 2/2	*		
9811	1121	9.1-3			2.4-3			2WAY	2/2, 2/2	*		
10811	1135	2.3-3			1.4-3			2WAY	2/2, 3/3	*		
11811	1150	1.6-3			1.3-3			2WAY	2/2, 2/2	*		
12811	1319	2.8-3			1.0-3			2WAY	2/2, 2/2	*		
13811	1357	2.3-3			3.3.3			2WAY	2/3, 2/2	*		
14811	1402	1.4-3			5.1-3			2WAY	2/2, 2/2	*		
15811	1428	4.0-4			5.1-3			2WAY	2/2, 2/2	*		
16811	1436	4.1-4			2.4-3			2WAY	2/2, 2/2	*		
17B22	1444	3.7-3			8.5-3			2WAY	2/2, 2/2	*		
18811	1446	1.2-2	0	1.0-5	1.1-2	0	0	2WAY	2/2, 2/2	*	AB	AB
19811	1602	3.1-3			6.1-4			(Traced Thru TER)	2/2, 2/2	*		
20811	1617	1.2-3			1.0-4			2WAY	2/2, 2/2	*		
								2WAY	2/2, 2/2			

Table C-2. Offut-Pentagon (Continued)

Call No.	EST Time	BER at Offut 16 kb/s	BER at Offut 8 kb/s	BER at Offut 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
21B11	1624	-			1.8-3			2WAV	- , 2/2	*		
22B11	1638	2.1-3			5.6-3			2WAV	2/2, 2/2	*		
23B11	1640	8.7-4			6.2-4			2WAV	2/2, 2/2	*		
24B11	1650	4.7-4			3.4-4			2WAV	2/2, 2/2	*		
25B11	1658	7.3-3			6.4-3			2WAV	2/2, 2/2	*		
26B11	1708	3.7-4			2.0-4			2WAV	2/2, 2/2	*		
27B11	1714	2.2-3			8.2-3			2WAV	2/2, 2/2	*		
28B11	1722	3.7-4			4.2-4			2WAV	2/2, 2/2	*		
29B11	1725	1.9-4			3.2-4			2WAV	2/2, 2/2	*		
30B11	1732	3.4-4			1.5-4			2WAV	2/2, 2/2	*		
31B11	1739	7.3-4			3.1-3			2WDT(SEG)	2/2, 2/2			
1A12	0903	1.5-3			2.0-3			2WDT(SEG)	2/2, 2/2		AB	
2A12	0913	1.4-3			1.9-3			2WDT(NOR)	2/2, 2/2		AB	
3A12	0919	3.1-3			1.2-3			2WDT(NOR)	2/2, 2/2		AB	
4A12	0923	-			1.4-1			2WDT(NOR)	- , 3/3		A	A

Table C-2. Offut-Pentagon (Continued)

Call No.	EST Time	BER at Offut 16 kb/s	8 kb/s	9.6 kb/s	BER at Pentagon 16 kb/s	8 kb/s	9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
5A12	0944	1.8-4			5.4-4			2WDT(NOR)	2/2, 2/2			
6A12	0953	8.0-4			4.0-3			2WDT(SEG)	2/2, 2/2		AB	
7A12	1015	4.4-3			8.3-3			2WDT(JAS)	3/3, 2/2			
8A12	1120	6.0-3			3.1-2	2.0-5	5.2-5	2WDT(MOS,SEG)	2/2, 2/2		A	A
9A12	1158	2.7-3			1.5-2	0	0	2WDT(JAS,NOR)	2/2, 2/2		A	A
10A12	1308	2.6-3			4.9-3			2WDT(POT,MOS)	2/2, 2/2		AB	
11A12	1335	6.3-3			1.2-2	0	0	2WDT(JAS,NOR)	2/2, 4/4		A	A
12A12	1405	5.9-3			6.3-3			2WDT(JAS,NOR)	2/2, 2/2		AB	
13A12	1414	5.7-3			1.0-2	1.0-5	0	2WDT(JAS,NOR)	2/2, 2/2		AB	A
14A12	1447	3.6-2	2.6-4	5.0-3	4.8-2	0	9.4-5	2WDT(POT,MOS,NOR)	2/2, 4/4		AB	B
15A12	1528	7.8-4			6.6-4			2WDT(SLO,SEG)	2/2, 2/2		AB	
16A12	1555	2.4-1	3.8-4	-	2.6-2	0	5.2-5	2WDT(SLO,SEG)	2/2, 2/2		A	A
17A12	1605	1.1-3			6.5-3			2WDT(SLO,SEG)	2/2, 4/4		AB	A
18A12	1625	6.1-3			8.5-3	0	0	2WDT(SLO,SEG)	4/4, 3/4		AB	A
19A12	1643	2.5-2	0	4.1-4	2.2-2	8.9-3	1.3-1	2WDT(POT,MOS,NOR)	3/3, 2/2		AB	AB

Table C-2. Offut-Pentagon (Continued)

Call No.	EST Time	BER at Offut 16 kb/s	8 kb/s	9.6 kb/s	BER at Pentagon 16 kb/s	8 kb/s	9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
20A12	1745	4.9-3			1.6-1	8.9-3	1.3-1	2WDT(JAS,SEG)	2/2, 2/2		A	
1A13	1000	7.6-4			2.8-3			2WAV	10/10, 11/11			
2A13	1013	5.4-4			4.2-4			DDD	2/2, 2/2			
3A13	1028	3.2-4			2.3-4			DDD	2/2, 4/4			
4A13	1038	1.1-4			2.8-4			DDD	2/2, 2/2			
5A13	1045	8.0-4			1.1-3			DDD	2/2, 2/2			
6A13	1050	3.0-4			2.6-4			DDD	2/2, 2/2			
7A13	1055	3.3-4			4.1-4			DDD	2/2, 2/2			
8A13	1100	7.3-4			6.3-4			DDD	2/2, 2/2			
9A13	1105	4.8-4			3.9-4			DDD	2/2, 2/2			
10A13	1108	1.0-3			5.8-4			DDD	2/2, 2/2			
11A13	1109	5.0-3			4.1-3			DDD	2/2, 2/2		AB	AB
12A13	1200	5.8-2	1.7-4	0	1.5-2	0	0	DDD	2/2, 2/2		AB	B
13A13	1230	4.4-2			4.1-3			DDD	2/2, 2/2			
14A13	1330	7.5-4			2.6-4			DDD	2/2, 2/2			

Table C-2. Offut-Pentagon (Continued)

Call No.	EST Time	BER at Offut 16 kb/s	BER at Offut 8 kb/s	BER at Offut 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
15A13	1335	1.3-4			9.0-5			DOD	2/2, 2/2			
16A13	1340	5.0-4			6.7-4			DOD	2/2, 2/2			
17A13	1345	3.0-4			0			DOD	2/2, 2/2			
18A13	1348	1.0-3			1.7-3			DOD	2/2, 2/2			
19B13	1505	8.6-4			4.1-3			4WSV	2/2, 2/2	*		
20B13	1510	1.2-3			8.9-3			4WSV	2/2, 2/2	*		
		3.0-2						AL	1/1, 2/2			
		1.7-3						DL	1/1, 2/2			
21B13	1542	1.7-3			6.0-3			4WSV	2/2, 2/2	*		
22B13	1545	1.5-3			-			4WSV	2/2, -	*		
23B13	1547	1.0-3			5.4-3			4WSV	2,2, 2/2	*		
24B13	1550	7.6-3			5.9-3			4WSV	2/2, 2/2	*		
		8.4-2						AL	1/1			
		1.6-2						DL	1/1			

Table C-2. Offut-Pentagon (Continued)

Call No.	EST Time	BER at Offut 16 kb/s	8 kb/s	9.6 kb/s	BER at Pentagon 16 kb/s	8 kb/s	9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
25B13	1600	4.4-4			1.0-3			4WSV	2/2, 2/2	*		
		2.4-2						AL	1/1			
		2.1-3						DL	1/1			
26B13	1605	5.3-4			4.9-3			4WSV	2/2, 2/2	*		
		2.8-2						AL	1/1			
		5.7-3						DL	1/1			
27B13	1613	6.7-4			4.3-3			SVDT(NOR)	2/2, 2/2	*		
		2.4-2						AL	1/1			
		5.6-3						DL	1/1			
28B13	1618	2.8-3			2.9-3			SVDT(NOR)	2/2, 3/3	*		
		2.2-2						AL	1/1			
		3.7-3						DL	1/1			
29B13	1634	9.0-3			8.3-3			SVDT(NOR,JAS)	2/2, 2/2	*		
		6.2-2						AL	1/1			
		1.5-2						DL	1/1			

Table C-2. Offut-Pentagon (Continued)

Call No.	EST Time	BER at Offut 16 kb/s	BER at Offut 8 kb/s	BER at Offut 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
30B13	1645	3.8-3			1.4-2	1.0-5	0	SVDT(NOR, JAS)	2/2, 2/2	*	A	A
		7.8-2						AL	1/1			
		1.7-2						DL	1/1			
31B13	1706	7.6-2	1.0-5	0	1.3-2	1.0-5	0	SVDT(NOR,MOS,POT)	2/2, 2/2	*	AB	AB
		1.0-1						AL	1/1			
		5.3-2						DL	1/4			
1A14	1005	-			2.1-3	(Remote at Pent)		2WAV	-, 1/1			
2A14	1038	-			2.1-2	(Remote at Pent)		2WDT (POT, MOS, NOR)	-, 2/2			
3A14	1047	-			2.3-3	(Remote at Pent)		2WDT (SLO, SEG)	-, 2/2			
4A14	1057	-			1.4-2	(Remote at Pent)		2WDT (JAS, NOR)	-, 1/1			
5A14	1157	3.1-4			0	(Remote at Pent)		2WAV	2/2, 2/2			
6A14	1207	1.2-2			1.5-4	(Remote at Pent)		2WAV	2/2, 2/2			
	Later	2.3-3										
7A14	1214	8.0-4			2.5-4	(Remote at Pent)		2WAV	2/3, 2/3			
8A14	1219	5.7-4			2.0-4	(Remote at Pent)		2WAV	2/2, 2/2			

Table C-3. March - Melbourne

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	BER at Melbourne 16 kb/s	BER at Melbourne 8 kb/s	BER at Melbourne 9.6 kb/s	Type of Call	No. of Syncs	Access Info.	Line Meas	Amp and Delay
15B18	1618	2.6-3			-			2WAV	2/2, -			
16B18	1635	3.0-3			-			2WAV	1/1, -			
17B18	1645	4.9-3			1.0-3			2WAV	2/2, 2/2			
18B18	1652	3.8-3			6.3-4			2WAV	2/2, 2/2			
19B18	1657	5.3-3			1.2-3			2WAV	2/2, 2/2			
20B18	1704	2.2-3			2.0-2			2WAV	2/2, 2/2			
21B18	1708	3.2-3			3.3-4			2WAV	2/2, 2/2			
22B18	1716	9.2-4			2.1-3			2WAV	2/2, 3/3			
23B18	1721	1.7-3			1.1-2			2WAV	2/2, 2/2			
24B18	1725	[illegible]			2.8-3			2WAV	2/2, 2/2			
25B18	1737	1.1-3			1.8-4			2WAV	2/2, 2/2			
26B18	1746	8.2-3			6.8-3			2WDT (SLO, SEG, JAS)	2/2, 2/2			
27B18	1758	9.6-3			6.4-3			2WDT (SEG, JAS)	2/2, 2/2			
28B18	1805	1.8-3			1.3-3			2WDT (SEG)	2/2, 2/2			
29H18	1810	6.8-3			4.7-3			2WDT (JAS, SEG, SLO)	2/2, 2/2			
30H18	1817	6.4-3			3.7-3			2WDT (JAS, SEG)	2/2, 2/2			

Table C-3. March - Melbourne (Continued)

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	BER at Melbourne 16 kb/s	BER at Melbourne 8 kb/s	BER at Melbourne 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
31M18	1827	2.9-3			1.7-3			2WDT (SEG)	2/2, 2/2			
1819	1130	1.3-2			3.0-3			2WAY	2/2, 2/2			
2819	1135	2.5-3			7.5-3			2WAY	2/2, 2/2			
3819	1155	1.2-2	5.5-4		3.8-4			2WDT (MOJ, ARL)	4/4, 2/2			
4819	1247	6.8-3			5.5-4			2WDT (MOJ, ARL)	4/4, 2/2			
5819	1255	1.6-2			5.2-3			2WDT (DRA, ARL)	2/2, 2/2			
6819	1312	7.3-2			3.6-2			2WDT (SLO, SEG, DRA, POT, ARL)	2/2, 3/3			
7819	1330	3.4-2			-			2WDT (SLO, SEG, ARL)	2/2, 2/2			
8819	1534	2.2-2	1.0-3		1.8-2			2WDT (SLO, SEG, ARL)	2/2, 2/2		B	B
9819	1800	2.0-3			1.4-3			2WDT (SEG)	2/2, 2/2			
10819	1805	2.6-2	4.0-5		5.2-3			2WDT (SEG, JAS)	2/2, 2/2		B	B
11819	1830	2.0-2			9.2-3			2WDT (SLO, SEG, JAS)	2/2, 2/2			
12H19	1840	1.3-3			4.0-3			2WDT (SEG)	2/2, 2/2			
13H19	1845	2.0-2			9.3-3			2WDT (SEG, JAS)	2/2, 2/2			

Table C-3. March - Melbourne (Continued)

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	BER at Melbourne 16 kb/s	BER at Melbourne 8 kb/s	BER at Melbourne 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
14H19	1850	7.4-2			3.0-2			2WDT (SLO, SEG, JAS)	2/2, 2/2			
15H19	1902	1.0-2			4.3-3			2WDT (JAS, SEG, SLO)	2/2, 2/2			
16H19	1910	1.8-2			7.7-3			2WDT (JAS, SEG)	2/2, 2/2			
17H19	1918	4.6-3			2.5-3			2WDT (SEG)	3/5, 2/2			
18H19	1934	1.7-2			7.1-3			2WDT (JAS, SEG)	2/2, 2/2			

Table C-3. March - Pentagon

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
1A21	1025	3.6-3			2.1-3			2WAV	2/2, 2/2			
2A21	1035	5.9-3			3.9-3			2WAV	2/2, 4/4			
3A21	1040	3.2-3			1.3-3			2WAV	2/2, 2/2			
4A21	1058	3.1-3			1.0-3			2WAV	2/2, 2/2			
5A21	1103	1.4-2			7.4-4			2WAV	2/2, 2/2			
	Later	5.6-3							2/2, 2/2			
6A21	1109	5.0-3			7.7-4				2/2, 2/2			
7A21	1113	4.4-3			1.2-3				-, 2/2			
8A21	1117	-			3.4-3				2/2, 2/2			
9A21	1120	7.8-3			1.2-3				2/2, 2/2			
10A21	1120	8.2-3			1.6-3				2/2, 2/2			
11A21	1130	2.9-2	7.0-5	0	1.8-2	0	0	2WDT (SEG)	2/2, 2/2		A	A
12A21	1237	1.5-2	1.9-4	4.2-4	7.1-3			2WDT (SLO)	2/2, 2/2		B	B
13A21	1253	8.8-3			6.7-3			2WDT (SEG, SLO)	2/2, 2/2			
14A21	1300	1.9-2	2.3-4	4.2-5	2.2-2	0	0	2WDT (JAS, SEG, SLO)	2/2, 6/7		AB	AB
15A21	1330	3.4-2	0	3.6-3	4.3-2	5.0-5	0	2WDT (POT, MOS, SEG)	2/2, 2/2		AB	AB

Table C 3. March - Pentagon (Continued)

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	BER at Pentagon 16 kb/s	BER at Pentagon 8 kb/s	BER at Pentagon 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
16A21	1350	5.0-2	4.3-4	0	6.5-2	5.0-5	2.5-4	2WOT (MOS, SEG, SLO)	2/2, 2/2		AB	B
17A21	1437	2.9-3			4.3-4			DDD	2/2, 2/2			
18A21	1438	1.4-3			8.4-4			DDD	2/2, 2/2			
19A21	1447	2.0-3			5.4-4			DDD	2/2, 2/2			
20A21	1453	2.4-3			7.4-4			DDD	2/2, 2/2			
21A21	1500	4.2-4			3.8-4			DDD	2/2, 2/2			
22A21	1515	3.8-4			3.8-4			DDD	2/2, 2/2			
23A21	1515	2.3-3			1.4-3			DDD	2/2, 2/2			
24A21	1525	4.6-4			7.4-4			DDD	3/3, 2/2			
25A21	1527	8.9-4			1.8-3			DDD	2/2, 2/2			
26A21	1530	1.0-1	1.5-3	4.5-2	1.0-3			DDD	3/3, 2/2		B	B

Table C-3. March - Ft. Meade

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	BER at Melbourne 16 kb/s	BER at Melbourne 8 kb/s	BER at Melbourne 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
1B17	1651	8.8-3			7.3-3			2WAV	4/4, 6/6			
101B19	1635	2.6-2			9.6-3			DDD	6/9, 2/2			
102B19	1652	1.0-2			4.8-2			DDD	1/1, 2/2		A	A
103B19	1705	1.3-2			4.7-2			DDD	2/2, 1/1			
101A20	1325	1.1-1			7.6-3			2WAV	2/2, 2/2		B	
102A20	1346	1.7-3			6.1-3			2WAV	3/3, 2/2	*		
103A20	1400	3.6-3			3.7-3			2WAV	2/2, 2/2	*		
104A20	1404	1.6-2			1.2-2	3.3-4	0	2WAV	2/2, 2/2	*		
105A20	1423	-			1.0-2			2WAV	-, 2/2	*		
106A20	1426	2.7-2	5.0-5	2.1-5	1.6-2	0	2.1-5	2WAV	2/2, 2/2	*	AB	AB
10[illegible]20	1507	6.3-3			9.7-3			2WAV	3/3, 2/2	*		
108A20	1513	7.2-3			4.6-3			2WAV	2/2, 2/2	*		
109A20	1530	6.4-2	5.2-4	2.6-4	7.1-2	2.6-4	7.5-4	2WAV	2/2, 2/2	*	AB	A

Table C-3. March - Ft. Meade (Continued)

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	BER at Melbourne 16 kb/s	BER at Melbourne 8 kb/s	BER at Melbourne 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
110A20	1800	3.9-2	4.0-4	6.2-5	5.1-2	0	2.3-4	2WAV	2/2, 2/2	*	AB	AB
111A20	1850	3.9-2	7.0-5	0	1.2-2	0	0	DDD	2/2, 2/2		AB	AB
112A20	1955	1.1-1	5.0-5	7.3-5	3.2-2	0	2.4-4	2WDT (SLO, ARL)	2/2, 2/2		AB	A
113A20	2016	1.1-1	4.2-4	2.6-4	9.3-2	0	3.1-5	2WDT (SLO, SEG, ARL)	2/2, 3/3		AB	AB

Table C-4. Pentagon Loops

Call No.	EST Time	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
1P06	0820	5.0-5			2.5-4			2W Loop	2/2, 2/2			
2P06	0836	0	0					2W Loop	2/2, 2/2			
3P06	0847	1.2-3			9.4-4			2W Loop	2/2, 2/2		A	A
4P06	0859	2.8-3			1.9-4			2W Loop	2/2, 2/2		AA	AA
5P06	0919	2.8-4			2.8-3			2W Loop	2/2, 2/2			
6P06	0922	4.1-4			4.2-4			2W Loop	2/2, 2/2			
7P06	0928	4.7-4			9.7-4			2W Loop	2/2, 2/2			
8P06	0930	1.0-3			5.0-1			2W Loop	2/2, 2/2		A	A
9P06	0939	5.7-4			1.8-4			2W Loop	2/2, 2/2			
10P05	0941	1.9-4			5.5-4			2W Loop	2/2, 2/2			
11P06	0946	6.4-4			1.8-3			2W Loop	2/2, 2/2			
12P06	0947	2.4-4			2.1-3			2W Loop	2/2, 2/2			
13P06	0953	9.1-4			8.9-4			2W Loop	2/2, 2/2			
14P06	0955	1.2-3			1.1-3			2W Loop	2/2, 2/2			
15P06	1000	8.2-4			2.7-3			2W Loop	2/2, 2/2			
16P06	1006	2.5-4			5.6-4			2W Loop	2/2, 2/2			
17P06	1008	8.6-4			3.4-3			2W Loop	2/2, 2/2			

Table C-4. Pentagon Loops (continued)

[illegible] No.	EST Time	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
18P06	101[illegible]	1.7-3			1.7-3			2W Loop	2/2, 2/2			
19P06	1015	1.5-2			8.7-3			2W Loop	2/2, 2/2		A	A
[illegible]	1037	8.3-4			1.7-3			2W Loop	2/2, 2/2			
21P06	1042	5.4-4			2.8-4			2W Loop	2/2, 2/2			
22P06	1047	9.6-4			6.8-4			2W Loop	2/2, 2/2			
[illegible]	105[illegible]	[illegible].3-4			4.2-4			2W Loop	2/2, 2/2			
24P06	1055	7.2-4			4.4-4			2W Loop	2/2, 2/2			
25P06	1102	6.7-4			4.4-4			2W Loop	2/2, 3/5			
26P06	1107	2.4-4			4.7-4			2W Loop	2/2, 2/2			
27P06	1110	1.3-3			2.7-1	1.0-1	0	2W Loop	2/2, 3/4		A	A
	1122				6.0-4			2W Loop	2/2, 2/2			
28P06	1126	5.4-4			-			2W Loop	2/2, 2/2			
29P06	1250	2.4-2	0	5.7-3	1.3-2	0	0	2W Loop	2/2, 2/2		AA	AA
1P07	0745	2.7-4			1.4-3			2W Loop	2/2, 2/2			
2P07	0753	7.7-3			6.5-3			2WDT (DRA)	2/2, 2/2			
3P07	0756	2.0-5			8.6-4			2WDT (ARL)	2/2, 2/2			

Table C-4. Pentagon Loops (Continued)

Call No.	EST Time	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
4P07	0803	1.4-2	0	0	1.7-3			2WDT (SEG)	2/2, 2/2		A	A
5P07	0820	8.2-2	1.6-4	5.4-2	7.7-2	3.0-5	1.1-2	2WDT (YAK)	2/2, 2/2		AA	AA
6P07	0852	1.5-2	0	0	1.6-2	0	5.2-5	2WDT (NOR)	2/2, 4/4		AA	AA
7P07	0904	5.3-2	0	0	2.6-2	0	0	2WDT (POT)	2/2, 2/2		A	
1P10	1058	2.0-5			1.9-4			2W Loop Via ARL Swbd	2/2, 2/2			
2P10	1115	3.6-4			2.0-4			2W Loop Via ARL Swbd	2/2, 2/2			
3P10	1123	2.5-4			1.0-5			2W Loop Via ARL Swbd	2/2, 2/2			
4P10	1132	1.0-5			0			2W Loop Via ARL Swbd	2/2, 2/2			
5P10	1141	5.0-5			1.3-4			2W Loop Via ARL Swbd	2/2, 2/2			
6P10	1422	6.5-4			3.2-4			2W Loop Via ARL Swbd	2/2, 2/2			
7P10	1434	1.5-2	0	7.0-3	-			2WDT (SLO)	2/2, 2/2		A	A
8P10	1506	2.2-3	1.0-5	4.9-4	-			2WDT (SLO)	2/2, 2/2		A	A
1P13	1737	-			1.6-3			2W Loop Via ARL	2/2, -			
2P13	1740	1.8-3			4.7-3			2WDT (ARL)	2/2, 2/2			
3P13	17[illegible]	5.0-5			2.5-3			2W Loop Via ARL	2/2, 2/2			

Table C-4. Pentagon Loops (Continued)

Call No.	EST Time	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	BER at 16 kb/s	BER at 8 kb/s	BER at 9.6 kb/s	Type of Call	No. of Syncs	Access Info	Line Meas	Amp and Delay
4P13	1748	1.2-3			1.2-3			2WDT (ARL)	2/2, 2/2			
5P13	1751	3.4-4			3.5-3			2W Loop Via ARL	2/2, 2/2			
6P13	1754	1.8-3			9.0-4			2WDT (ARL)	2/2, 2/2			
7P13	1757	0			0			2W Loop Via ARL	2/2, 2/2			

Table C-4. MacDill Loops

Call No.	EST Time	BER at MacDill 16 kb/s	8 kb/s	9.6 kb/s	Type of Call	Looped To	No. of Sync	Access Info	Line Meas	Amp and Delay
1005	1255	5.0-2			2 W-L	POL				
1006	0900	5.1-2			2 WL-33/34	POL	1/1	*		
		1.8-1			34/33	POL	2/2			
2006	0932	1.0-1			2 WL	POL	1/1	*		
		4.5-4	(Echos Removed at POL)				1/1			
3006	1040	0			2 WL-34/33	PBX	1/1	*		
4006	1045	1.5-1			2 WL	POL	1/1	*		
5006	1050	1.9-4			2 WL-34/33	POL	1/1	*		
6006	1145	5.2-4			2 WL	POL	1/1	*		
7006	1200	4.6-3			2 WL	POL	1/1	*		
1007	0850	1.1-1			2 WL	POL	4/4	*		
		2.5-3	(10 db RCV Pad, No TX Pad)							
		2.8-3	(6 db RCV Pad, No TX Pad)							
		4.2-4	(6 db TX Pad, No RCV Pad)							

Table C-4. Offut Loops

Call No.	EST Time	BER at Offut 16 kb/s	8 kb/s	9.6 kb/s	Type of Call	Looped To	No. of Sync	Access Info	Line Meas	Amp and Delay
1010	-	2.3-4			2W AV Loop	LYO/FVW	2/2			
2010	-	1.2-4			2W AV Loop	LYO/FVW	2/2			
3010	-	2.9-4			2W AV Loop	LYO/FVW	2/2			
4010	-	2.1-3			2W AV Loop	LYO/FVW	2/2			
5010	-	4.3-4			2W AV Loop	LYO/FVW	2/2			
22013	1736	6.3-4			4W SV Loop	LYO	1/1	•	P	
23013	1744	0			4W SV Loop	LYO	1/1	•	[illegible]	
34013	1745	0			4W SV Loop	LYO	1/1	•	[illegible]	
35013	1748	6.[illegible]-4			4W SV Loop	LYO	1/1	•	[illegible]	
36013	1750	1.0-5			4W SV Loop	YO	1/1	•	[illegible]	
37013	1754	[illegible]			4W SV Loop	YO	1/1	•	[illegible]	

Table C-4. March Loops

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	Type of Call	Looped To	No. of Sync	Access Info	Line Meas	Amp and Delay
1M17	1815	9.0-5			2W AV Loop	Riverside	1/1			
2M17	1815	0			2W AV Loop	PBX	1/1	*		
3M17	1820	1.9-4			2W AV Loop	Riverside	1/1	*		
4M17	1919	1.8-3			2WAV (JUL-MOJ)	Riverside	2/2	*		
5M17	1943	1.5-3			2W DT (SLO)	Riverside	2/2	*		
6M17	1957	4.4-3			2W DT (SLO)	Riverside	1/1	*		
7M17	2001	6.6-3			2W DT (SLO)	Riverside	2/3	*	B	B
1M18	1035	9.3-2			2W AV Loop	JUL	2/2	*		
2M18	1045	3.8-3			2W AV Loop	JUL	2/2	*		
3M18	1055	2.4-3			2W AV Loop	JUL	2/2	*		
4M18	1100	3.1-4			2W AV Loop	JUL	2/2	*		
5M18	1101	2.7-4			2W AV Loop	JUL	3/4	*		
6M18	1105	8.6-4			2W AV Loop	MOJ	4/4	*		
7M18	1122	1.4-3			2W AV Loop	MOJ	2/2	*		
8M18	1125	3.8-3			2W AV Loop	MOJ	2/2	*		
9M18	1135	3.9-3			2W AV Loop	MOJ	2/2	*		
10M18	1150	1.7-3			2W AV Loop	MOJ	2/2	*		
11M18	1213	1.0-3			2W AV Loop	MOJ	2/3	*	B	B
12M18	1254	7.0-4			2W AV Loop	MOJ	2/2	*	B	

Table C-4. March Loops (Continued)

Call No.	EST Time	BER at March 16 kb/s	BER at March 8 kb/s	BER at March 9.6 kb/s	Type of Call	Looped To	No. of Sync	Access Info	Line Meas	Amp and Delay
13M18	1307	9.8-4			2W AV Loop	MOJ	2/2	*	B	B
14M18	1330	1.4-3			2W AV Loop	JUL	2/2	*	B	B
1M20	1036	2.4-3			2W DT (SLO)	-	2/2	*	B	B
2M20	1120	2.0-2	9.5-4		2W DT (SLO-SEG)	-	2/2	*	B	B
3M20	1158	9.4-2	2.6-4	1.7-2	2W DT (SLO-SEG-JAS)	-	2/2			
4M20	1230	2.3-2	0	3.1-5	2W DT (SLO-SEG-JAS)	-	2/2		B	B

Table C-4. Meade Loops

Call No.	EST Time	BER at Meade 16 kb/s	8 kb/s	9.6 kb/s	BER at Meade 16 kb/s	8 kb/s	9.6 kb/s	Type of Call	No. of Sync	Access Info	Line Meas	Amp and Delay
1N17	1615	-			2.3-2	0	0	2W AV Loop	-, 1/1		A	A
2N17	1721	2.3-1			3.1-2			2W AV Loop	2/2, 2/2		AA	AA
3N17	1741	5.3-2			-			2W AV Loop	2/2, -		AA	AA
4N17	1745	2.7-2			3.2-2			DDD	2/2, 2/2		A	A
	Later	6.0-4			6.8-4							
5N17	1808	3.3-3			-			DDD	3/3, -		A	A
1N18	1305	2.9-2			2.3-2			2W AV Loop	1/1, 1/1	*	AA	AA
2N18	1320	9.2-3			1.2-2			2W AV Loop	2/2, 2/2	*	AA	AA
	1325	1.4-3			7.1-4			2W AV Loop	2/2, 1/1	*	AA	AA
3N18	1345	4.1-3			2.3-2			2W AV Loop	2/2, 1/1	*	AA	AA
	1346				4.6-3			2W AV Loop				
4N18	1417	2.3-2			3.6-2			2W AV Loop	1/1, 1/1	*	AA	AA
5N18	1434	1.7-1			9.4-3			2W AV Loop	1/1, 1/1	*	AA	A
6N18	1445	1.7-2			2.0-1			2W AV Loop	1/1, 1/1	*		
7N18	-	6.0-2			2.0-1			2W AV Loop	1/1, 1/1	*	AA	A
8N18	1538	1.0-1			4.8-2	2.0-5	3.1-5	2W AV Loop	1/1, 1/1	*	AA	AA
1N19	0945	1.3-2	0	0	4.9-2	1.0-5	4.2-5	2W AV Loop	1/1, 1/1	*	AA	AA
2N19	1037	7.6-4			2.1-4			2W AV Loop	1/1, 1/1	*	A	A
3N19	1100	6.0-2	3.0-5	2.2-4	2.4-1	6.5-2	6.9-2	2W AV Loop	1/1, 1/1	*	AA	AA

Table C-4. Meade Loops (Continued)

Call No.	EST Time	BER at Meade [illegible] kb/s	BER at Meade 8 kb/s	BER at Meade 9.6 kb/s	BER at Meade 16 kb/s	BER at Meade 8 kb/s	BER at Meade 9.6 kb/s	Type of Call	No. of Sync	Access Info	Line Meas	Amp and Delay
4N19	1132	7.7-2	6.7-4	1.7-4	6.2-2	4.0-4	2.1-5	2W AV Loop	1/1, 1/1	*	AA	AA
5N19	-	-			-			2W AV Loop	-, -			
6N19	1415	4.9-2	0	[illegible].2-4	[illegible].8-2	0	0	2W AV Loop	2/2, 1/1	*	AA	AA
7N19	-	5.2-2	0	9.4-5	5.0-2	0	5.2-5	2W AV Loop	1/1, 1/1	*	AA	AA
8N19	-	5.[illegible]-2	1.0-5	-	5.3-2			2W AV Loop	1/1, 1/1	*		
1N20	0918	2.[illegible]-4			9.0-5			2W AV Loop	2/2, 1/1	*	A	A
2N20	1015	3.1-2	1.1-4	0	5.3-2	5.0-5	2.3-4	2W AV Loop	1/1, 1/1	*	AA	AA
3N20	1645	1.8-4			-			2W AV Loop	1/1 -	*	A	A

Table C-5. Line Measurements (A)

						Harmonic Distortion					Hits			
Call No.	RCV Sig.	S/N	Tone	T/N	Offset	2nd	3rd	PJ	+3db	+20°	71	75	79	O.O.
2B03	-18	-	-19	29	0	35	31	5	0	0	0	0	0	0
10B04	-	-	-	34	0	43	36	3.5	-	-	-	-	-	-
29B04	-16	18	-17	33	0	36	34	6	5	4	8	2	1	0
2B05	-20	-	-	-	-	-	-	-	-	-	-	-	-	-
10B05	-16	32	-18	31	0	40	36	7	0	109	1	1	0	0
3P06	-17	50	-18	35	0	49	36	0	-	-	-	-	-	-
4P06	-17	45	-17	34	0	42	37	0	-	-	-	-	-	-
4P06	-17	43	-18	37	0	49	36	0	-	-	-	-	-	-
8P06	-18	45	-39	15	0	38	24	1	-	-	-	-	-	-
19P06	-18	41	-18	34	0	31	36	1.5	0	0	0	0	0	0
27P06	-17	38	-18	35	0	39	37	-	-	-	-	-	-	-
29P06	-16	41	-18	35	0	37	33	2	0	0	0	0	0	0
29P06	-16	41	-16	33	0	43	33	1.5	-	-	-	-	-	-
4P07	-	-	-14	33	0	37	32	2	0	0	0	0	0	0
5P07	-8	46	-12	29	0	38	34	6	-	-	-	-	-	-
5P07	-8	49	-15	30	0	35	36	7	-	-	-	-	-	-
6P07	-8	55	-17	34	0	38	31	2	-	-	-	-	-	-
6P07	-8	52	-15	32	0	44	32	2	-	-	-	-	-	-
7P07	-8	54	-16	34	0	42	29	8	-	-	-	-	-	-
10A07	-8	42	-6	31	0	48	36	4	0	0	0	1	1	0
13A07	-12	34	-11	29	0	37	36	10	-	-	-	-	-	-
7P10	-	35	-	28	0	38	51	6	0	1	0	0	0	0
8P10	-	37	-	33	0	∞	34	4	0	3	0	0	0	0
2B10	-	38	-	33	0	48	35	3	0	0	0	0	0	0
9A10	-	34	-	28	0	31	37	7	-	-	-	-	-	-
1B11	-	30	-	28	0	42	33	12	0	0	0	0	0	0
18B11	-	35	-	28	-	39	32	0	3	0	0	0	0	0
1A12	-	36	-	34	-	34	36	-	-	-	-	-	-	-
2A12	-	37	-	34	-	40	34	-	-	-	-	-	-	-
3A12	-	35	-	39	-	42	33	-	-	-	-	-	-	-
4A12	-	38	-	35	-	41	33	-	-	-	-	-	-	-
6A12	-	-	-	33	-	39	32	-	-	-	-	-	-	-
8A12	-	45	-	30	0	40	27	5	0	0	4	3	2	0
9A12	-	-	-	34	0	46	30	5	-	-	-	-	-	-
10A12	-	39	-	26	0	36	31	8	-	-	-	-	-	-
11A12	-	39	-	31	0	44	31	4	-	-	-	-	-	-

Table C-5. Line Measurements (A) (Continued)

Call No.	RCV Sig.	S/N	Tone	T/N	Offset	Harmonic Distortion 2nd	3rd	PJ	+3db	+20°	Hits 71	75	79	D.O.
12A12	-	40	-	34	0	45	31	4	-	-	-	-	-	-
13A12	-	40	-	34	0	43	31	4	-	-	-	-	-	-
14A12	-	41	-	30	0	43	31	9	-	-	-	-	-	-
15A12	-	44	-	32	0	48	38	4	-	-	-	-	-	-
16A12	-	43	-	32	0	39	31	6	-	-	-	-	-	-
17A12	-	42	-	32	0	42	34	6	-	-	-	-	-	-
18A12	-	41	-	31	0	35	46	8	-	-	-	-	-	-
19A12	-	44	-	30	0	34	28	9	-	-	-	-	-	-
20A12	-	42	-	33	0	29	42	6	-	-	-	-	-	-
11A13	-	37	-	35	0	34	44	2	0	0	1	0	0	0
12A13	-	35	-	36	0	36	44	7	0	0	0	0	0	0
30B13	-	41	-	33	0	41	30	6	-	-	-	-	-	-
31B13	-	41	-	31	0	39	30	10	-	-	-	-	-	-
1N17	-	-	-	34	0	39	32	3	-	-	-	-	-	-
2N17	-	-	-	27	-	34	30	6	-	-	-	-	-	-
2N17	-	-	-	25	0	31	27	3	-	-	-	-	-	-
3N17	-	-	-	25	-	27	34	9	-	-	-	-	-	-
3N17	-	-	-	29	0	33	28	4	-	-		-	-	-
4N17	-	-	-	56	-	65	61	0	-	-	-	-	-	-
5N17	-	-	-	54	-	64	62	0	-	-	-	-	-	-
1N18	-	35	-	32	0	34	30	3	0	0	50	0	0	0
1N18	-	42	-	35	0	27	32	9	-	-	-	-	-	-
2N18	-	31	-	32	0	41	31	7	-	-	-	-	-	-
2N18	-	-	-	36	-	30	30	3	-	-	-	-	-	-
3N18	-	31	-	37	0	30	33	2	-	-	-	-	-	-
3N18	-	34	-	33	-	39	32	-	-	-	-	-	-	-
4N18	-	35	-	34	0	31	28	3	-	-	-	-	-	-
4N18	-	36	-	30	0	33	29	2	-	-	-	-	-	-
5N18	-	36	-	29	0	29	31	[illegible]	-	-	-	-	-	-
5N18	-	38	-	31	0	35	32	4	-	-	-	-	-	-
7N18	-	28	-	40	0	40	45	0	-	-	-	-	-	-
7M18	-	36	-	30	-	30	27	3	-	-	-	-	-	-
8N18	-	40	-	23	-	30	32	8	-	-	-	-	-	-
8N18	-	36	-	31	-	38	26	3	0	0	40	4	2	0
1N19	-	31	-	32	0	32	30	3	0	0	1	0	0	0
1N19	-	42	-	26	0	40	37	10	0	0	5	1	0	0

Table C-5. Line Measurements (A) (Continued)

Call No.	RCV Sig.	S/N	Tone	T/N	Offset	Harmonic Distortion 2nd	3rd	PJ	+3db	+20°	Hits 71	75	79	D.O.
2N19	-	34	-	32	0	34	37	3	-	-	-	-	-	-
3N19	-	35	-	27	0	35	27	4	0	0	0	0	0	0
3N19	-	37	-	29	0	31	27	4	-	-	-	-	-	-
4N19	-	42	-	24	0	28	32	10	0	0	14	5	0	0
4N19	-	37	-	25	0	28	29	3	0	0	77	55	5	0
6N19	-	32	-	30	0	36	28	4	1	0	21	14	8	1
6N19	-	35	-	30	0	33	28	5	0	0	0	0	0	0
7N19	-	36	-	28	0	28	28	4	0	0	3	0	0	0
7N19	-	32	-	29	0	28	28	0	0	0	0	0	0	0
102B19	-	37	-	29	0	33	33	5	-	-	-	-	-	-
1N20	-	32	-	17	0	18	35	3	-	-	-	-	-	-
2N20	-	28	-	39	0	44	41	1	0	0	0	0	0	0
2N20	-	26	-	39	0	44	38	5	6	1	9	3	1	0
2N20	-	33	-	30	-	34	29	5	3	2	23	8	0	0
2N20	-	36	-	28	0	31	28	6	0	0	0	0	0	0
104A20	-	43	-	32	0	44	34	6	-	-	-	-	-	-
106A20	-	42	-	31	0	43	30	7	0	0	0	0	0	0
109A20	-	42	-	23	-	27	30	10	0	0	2	2	2	0
3N20	-	28	-	33	0	51	40	2	0	1	10	6	4	0
110A20	-	41	-	27	0	31	27	8	0	0	0	0	0	0
111A20	-	40	-	27	0	28	44	4	0	0	2	2	2	0
112A20	-	46	-	31	0	30	27	6	0	0	0	0	0	0
113A20	-	45	-	31	0	37	30	7	0	78	7	5	1	0
11A21	-	42	-	29	0	41	31	4	-	-	-	-	-	-
14A21	-	45	-	29	0	39	30	9	-	-	-	-	-	-
15A21	-	41	-	31	0	38	30	9	-	-	-	-	-	-
16A21	-	46	-	30	0	36	27	9	-	-	-	-	-	-
				Line Measurements (B)										
2B03	-16	-	-	33	0	42	31	5	0	0	9	4	2	0
7A04	-15	-	-	38	-	43	35	2	-	-	-	-	-	-
9B04	-15	-	-	29	0	-	-	2.5	-	-	-	-	-	-
12B04	-19	-	-	35	-	42	36	6	-	-	-	-	-	-
26B04	-16	34	-	37	-	42	42	2	0	11	46	33	16	0
31B04	-17	46-23	17	37	-	58	45	3	2	0	14	10	5	0
35B04	-16	-	16	37	-	49	37	6	-	-	-	-	-	-

Table C-5. Line Measurements (B) (Continued)

Call No.	RCV Sig.	S/N	Tone	T/N	Offset	2nd	3rd	PJ	+3db	+20°	Hits 21	Hits 25	Hits 29	Hits [illegible]
3805	-17	30	19	37	0	39	37	5	0	0	30	17	4	[illegible]
7805	-14	-	-	-	-	45	34	-	-	-	-	-	-	-
9805	-22	25	22	30	0	39	39	6	0	5	1495	750	134	[illegible]
10805	-17	29	15	31	0	44	32	4-22	0	41	[illegible]	163	[illegible]	[illegible]
2806	-11	36	11	33	0	38	35	3	0	126	944	[illegible]	63	0
3806	-19	28	19	42	-	55	52	3	0	0	51	38	19	[illegible]
5806	-16	31	16	42	-	∞	48	4	0	1	47	19	[illegible]	[illegible]
10A07	-9	36	8	34	0	34	36	4	0	0	0	6	[illegible]	0
12A07	-12	-	12	31	-	35	29	10	-	-	-			-
[illegible]	-	24	-	31	-	33	39	4	0	0	0	-	-	-
9B10	-	23	-	27	0	42	39	9	-	-		-	-	-
9B10	-	22	-	27	0	42	39	9	-	-	-		-	
1B11	-	26	-	29	0	44	33	8	1	9	34	-	-	-
[illegible]	-	28	-	28	0	36	32	9	1	1	26	-	-	-
1A12	-	-	-	32	-	-	-	-	-		-	-	-	-
2A12	-	-	-	32	0	44	34	-	-	-	-	-	-	-
3A12	-	-	-	33	-	40	33	-	-	-	-	-	-	-
6A12	-	-		32	0	43	35	3	-	-	-	-	-	-
10A12	-	-	-	30	-	35	30	-	-	-	-	-		-
12A12	-	-	-	28	0	40	29	5	-	-	-	-	-	-
[illegible]	-	-	-	33	0	39	31	5	-	-	-	-		-
14A12	-	-	-	29	0	30	27	8	-	-	-			-
15A12	-	-		29	-	49	33	4	-	-	-	-	-	-
17A12	-	-	-	30	0	45	33	[illegible]	-	-	-	-		-
18A12	-	-		28	0	43	36	8	-	-				
19A12	-	-	-	[illegible]	0	39	29	13	-	-	-	-		
11A13	-17	-		38	0	49	41	2	229	[illegible]	6	-		[illegible]
12A13	-	-	-	41	0	48	40	2	56	10	[illegible]	[illegible]	[illegible]	[illegible]
31B13	-	-		28	0	37	26	9	-	-			-	
32013	-	-	-	31	0	35	38	2	-			-	-	
33013	-	-	-	38	-	61	41	-	-	-	-	-	-	
34013		-		39	-	44	42	-	-	-				
35013	-	-	-	31	-	35	39	-	-	-	-			
36013	-	-	-	37	-	43	35	-	-			-		
37013	-	-		39		45	36	-						-
7M17	-14	-	-	36	-	48	30	3	0	0	0	-		-

Table C-5. Line Measurements (B) (Continued)

Call No.	RCV Sig.	S/N	Tone	T/N	Offset	2nd	3rd	PJ	+3db	+20°	Hits 71	Hits 75	Hits 79	D.O.
11M18	-14	-	-	39	0	42	34	1	0	0	0	0	0	0
12M18	-	-	-	40	0	39	34	2	-	-	-	-	-	-
13M18	-	-	-	33	-	44	33	2	12	2	1	0	0	0
14M18	-	-	-	38	-	44	41	1	0	0	1	1	1	0
8B19	-	-	-	33	3	45	32	5	0	0	2	2	1	0
10B19	-	-	-	32	-	40	35	3	0	3	27	14	9	0
1M20	-	-	-	35	-	45	34	3	0	0	0	0	0	0
2M20	-	-	-	33	-	40	33	13	6	79	26	20	18	0
4M20	-	-	-	41	0	43	32	8	0	13	10	7	4	0
101A20	-	-	-	31	0	45	31	10	-	-	-	-	-	-
106A20	-	-	-	28	-	42	27	6	0	2	0	0	0	0
109A20	-	-	-	27	-	34	28	11	1	0	1	0	0	0
110A20	-	-	-	27	-	42	28	9	0	0	1	1	1	0
111A20	-	-	-	29	-	38	34	4	0	0	0	0	0	0
112A20	-	-	-	29	-	36	26	5	0	2	9	4	1	0
113A20	-	-	-	26	-	36	27	8	[illegible]	0	26	17	10	0
12A21	-	-	-	30	-	37	34			-	-	-	-	-
14A21	-	-	-	30	-	42	28			-	-	-	-	-
15A21	-	-	-	30	-	42	26		-	-	-	-	-	-
16A21	-	-	-	29	-	41	24	9	-	-	-	-	-	-
26A21	-	-	-	22	-	36	18	4	-	-	-	-	-	-

Table C-6. Access Line Information

Call No.	From	Via	Access Line	To	Via	Access Line	Comments
30B04	MacDill	POL	9GP1003-016	Pent.	ARL/DRA	-	
31B04	MacDill	POL	9GP1003-016	Pent.		-	
32B04	MacDill	POL	9GP1003-016	Pent.	-	-	
33B04	MacDill	POL	9GP1003-017	Pent.	-	-	Sage
34B04	MacDill	POL	9GP1003-017	Pent.	-	-	Sage
35B04	MacDill	POL	9GP1003-017	Pent.	-	-	Sage
1M06	MacDill	POL	9GP1003-004	MacDill	POL	-014	Via Tampa
2M06	MacDill	POL	9GP1003-014	MacDill	POL	-004	Via Tampa
5M06	MacDill	POL	-	MacDill	POL	-	Via Sage
6M06	MacDill	POL	9GP1003-024	MacDill	POL	-033	Via Sage
7M06	MacDill	POL	9GP1003-033	MacDill	POL	-001	Out on Sage In Via Tampa
1B06	MacDill	POL	9GP1003-020	Pent.	ARL/DRA	-	Sage
2B06	MacDill	POL	9GP1003-012	Pent.	ARL/DRA	-	Tampa
8B06	MacDill	POL	9GP1003-013	Pent.	ARL/DRA	-	Tampa
9B06	MacDill	POL	9GP1003-017	Pent.	ARL/DRA	-	Sage
10B06	MacDill	POL	9GP1003-034	Pent.	ARL/DRA	-	?
1A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
2A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
3A07	Pent.	ARL	LYQU	MacDill	POL	[illegible]	Autosevocom
4A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
5A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
6A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
7A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
8A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
9A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
10A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
11A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
12A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
13A07	Pent.	ARL	LYQU	MacDill	POL	GP-30819-001	Autosevocom
14A07	Pent.	ARL	LYQU	MacDill	ELI	GP-30819-[illegible]	Autosevocom
15A07	Pent.	ARL	LYQU	MacDill	ELI	GP-30819-00[illegible]	Autosevocom
16A07	Pent.	ARL	LYQU	MacDill	ELI	GP-30819-002	Autosevocom
17A07	Pent.	ARL	LYQU	MacDill	ELI	GP-30819-002	Autosevocom
1B11	Offut	LYO	GP77010-019[illegible]	Pent.	ARL/DRA	-	
2B11	Offut	FVW	GP67944-024F	Pent.	ARL/DRA	-	
3B11	Offut	LYO	GP67944-020I	Pent.	ARL/DRA	-	
4B11	Offut	FVW	GP67944-021F	Pent.	ARL/DRA	-	

Table C-6. Access Line Information (Continued)

Call No.	From	Via	Access Line	To	Via	Access Line	Comments
5B11	Offut	LYO	GP67944-002L	Pent.	ARL/DRA	-	
6B11	Offut	FVW	GP67944-002F	Pent.	ARL/DRA	-	
7B11	Offut	LYO	GP67944-005L	Pent.	ARL/DRA	-	
8B11	Offut	FVW	GP67944-004F	Pent.	ARL/DRA	-	
9B11	Offut	LYO	GP67944-004L	Pent.	ARL/DRA	-	
10B11	Offut	LYO	GP67944-024L	Pent.	ARL/DRA	-	
11B11	Offut	FVW	GP67944-001F	Pent.	ARL/DRA	-	
12B11	Offut	LYO	GP67944-003L	Pent.	ARL/DRA	-	
13B11	Offut	FVW	GP67944-003F	Pent.	ARL/DRA	-	
14B11	Offut	LYO	GP77050-001L	Pent.	ARL/DRA	-	
15B11	Offut	FVW	GP77050-043F	Pent.	ARL/DRA	-	
16B11	Offut	FVW	GP77050-048F	Pent.	ARL/DRA	-	
17B11	Offut	LYO	GP77050-014L	Pent.	ARL/DRA	-	
18B11	Offut	FVW	GP77050-019F	Pent.	ARL/DRA	-	
19B11	Offut	FVW	-	Pent.	ARL/DRA	-	
20B11	Offut	FVW	GP77050-001F	Pent.	ARL/DRA	-	
21B11	Offut	LYO	GP77050-055L	Pent.	ARL/DRA	-	
22B11	Offut	LYO	GP77050-023L	Pent.	ARL/DRA	-	
23B11	Offut	FVW	GP77050-003F	Pent.	ARL/DRA	-	
24B11	Offut	FVW	GP77050-004F	Pent.	ARL/DRA	-	
25B11	Offut	LYO	GP77050-020L	Pent.	ARL/DRA	-	
26B11	Offut	FVW	GP77050-011F	Pent.	ARL/DRA	-	
27B11	Offut	LYO	GP77050-057L	Pent.	ARL/DRA	-	
28B11	Offut	FVW	GP77050-051F	Pent.	ARL/DRA	-	
29B11	Offut	FVW	GP77050-047F	Pent.	ARL/DRA	-	
30B11	Offut	FVW	GP77050-049F	Pent.	ARL/DRA	-	
19B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
20B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
21B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
22B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
23B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
24B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
25B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
26B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
27B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
28B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
29B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom
30B13	Offut	LYO	GP77050-003	Pent.	ARL	LYQT	Autosevocom

Table C-6. Access Line Information (Continued)

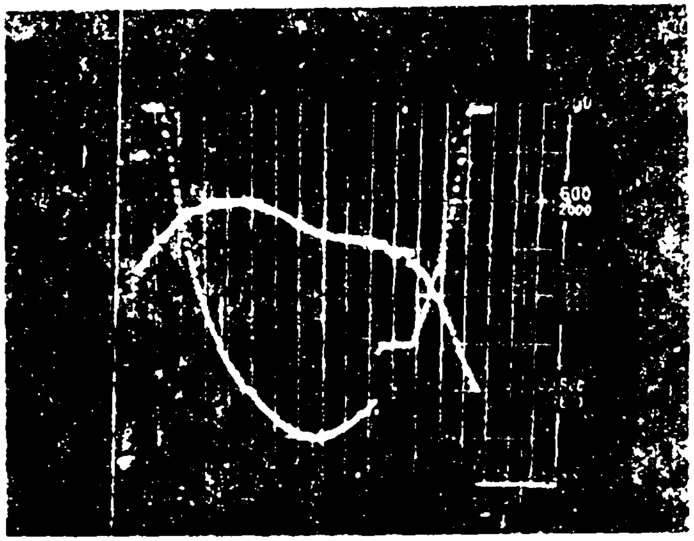
Call No.	From	Via	Access Line	To	Via	Access Line	Comments
						LYQT	Autosevocom
31813	Offut	LYO	GP77050-003	Pent.	ARL	-003	Autosevocom Loops (E Sig. Unit)
32013	Offut	LYO	GP77050-003	Offut	LYO	-001	Autosevocom Loops (F Sig. Unit)
33013	Offut	LYO	GP77050-001L	Offut	LYO	-002	Autosevocom Loops (E Sig. Unit)
34013	Offut	LYO	GP77050-002L	Offut	LYO	-003	Autosevocom Loops (E Sig. Unit)
35013	Offut	LYO	GP77050-003L	Offut	LYO	-004	Autosevocom Loops (E Sig. Unit)
36013	Offut	LYO	GP77050-004L	Offut	LYO	-005	Autosevocom Loops (E Sig. Unit)
37013	Offut	LYO	GP77050-005L	Offut	LYO		
3M17	March	JUL	J042	March	JUL/MOJ	-	L3
4M17	March	JUL	J007	March	MOJ	M022	L3
5M17	March	MOJ	M012	March	JUL/MOJ	-	Cable - T2103-L3
6M17	March	MOJ	M002	March	JUL/MOJ	-	Cable - T2103-L3
7M17	March	MOJ	M003	March	JUL/MOJ	-	Cable - N2-L3
1M18	March	JUL	J031	March	JUL/MOJ	-	L3

Table C-6. Access Line Information (Continued)

Call No.	From	Via	Access Line	To	Via	Access Line	Comments
2M18	March	JUL	J005	March	JUL/MOJ	-	L3
3M18	March	JUL	J003	March	JUL/MOJ	-	L3
4M18	March	JUL	J007	March	JUL/MOJ	-	L3
5M18	March	JUL	J007	March	JUL/MOJ	-	L3
6M18	March	MOJ	M003	March	JUL/MOJ	-	N2
7M18	March	MOJ	M011	March	JUL/MOJ	-	N2
8M18	March	MOJ	M013	March	JUL/MOJ	-	N2
9M18	March	MOJ	M015	March	JUL/MOJ	-	N2
10M18	March	MOJ	M002	March	JUL/MOJ	-	T2 and L3
11M18	March	MOJ	M012	March	JUL/MOJ	M018	T2 out, cable in
12M18	March	MOJ	M003	March	JUL/MOJ	-	N2 and L3
13M18	March	MOJ	M003	March	JUL/MOJ	-	N2 out, T2 in
14M18	March	JUL	-	March	JUL	J039	L3
1N18	Ft. Meade	MON	006	Ft. Meade	MON	011	N1-T
2N18	Ft. Meade	MON	001	Ft. Meade	MON	010	T1-N1
3N18	Ft. Meade	MON	012	Ft. Meade	MON	001	1-T
4N18	Ft. Meade	MON	009	Ft. Meade	MON	012	N1-T
5N18	Ft. Meade	MON	014	Ft. Meade	MON	008	1-N1
6N18	Ft. Meade	MON	008	Ft. Meade	MON	017	N1-T1
7N18	Ft. Meade	MON	008	Ft. Meade	MON	006	N1-N1
8N18	Ft. Meade	MON	006	Ft. Meade	MON	002	N1-T1
1N19	Ft. Meade	MON	004	Ft. Meade	MON	006	T1-N1
2N19	Ft. Meade	MON	007	Ft. Meade	MON	004	N1-T1
3N19	Ft. Meade	MON	008	Ft. Meade	MON	002	N1-N1
4N19	Ft. Meade	MON	006	Ft. Meade	MON	002	T1/D1A-N1
6N19	Ft. Meade	MON	-	Ft. Meade	MON	-	T1/D18
7N19	Ft. Meade	MON	007	Ft. Meade	MON	008	N1-N1
8N19	Ft. Meade	MON	007	Ft. Meade	MON	008	N1-N1
1N20	Ft. Meade	MON	007	Ft. Meade	MON	008	N2-N2
102A20	Ft. Meade	MON	-	March	JUL/MOJ	-	N2 at Ft. Meade
103A20	Ft. Meade	MON	-	March	JUL/MOJ	-	N2 at Ft. Meade
104A20	Ft. Meade	MON	-	March	JUL/MOJ	-	N2 at Ft. Meade
105A20	Ft. Meade	MON	001	March	JUL/MOJ	-	T1/D1D at Ft. Meade
106A20	Ft. Meade	MON	001	March	JUL/MOJ	-	T1/D1D at Ft. Meade
107A20	Ft. Meade	MON	001	March	JUL/MOJ	-	T1/D1B at Ft. Meade
108A20	Ft. Meade	MON	007	March	JUL/MOJ		N2 at Ft. Meade
109A20	Ft. Meade	MON	002	March	JUL/MOJ	-	T1/D1A at Ft. Meade
3N20	Ft. Meade	MON	002	Ft. Meade	MON	-	T1/D1D loop
110A20	Ft. Meade	MON	007	March	JUL/MOJ		N1 at Ft. Meade

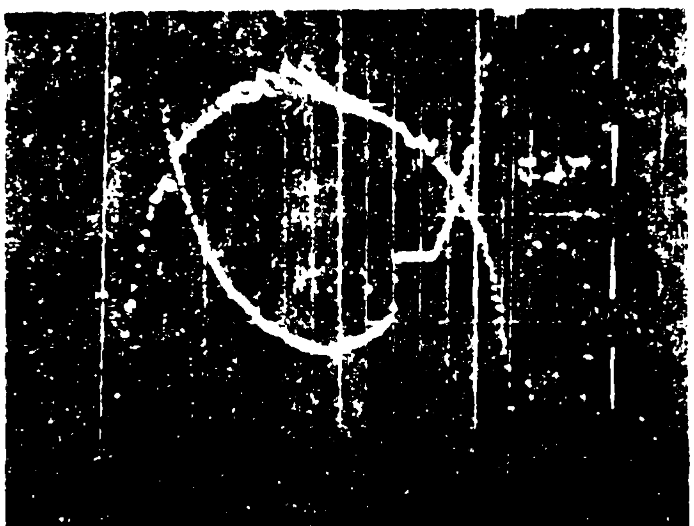
TABLE C-7

AMPLITUDE AND DELAY RESPONSE MEASUREMENTS

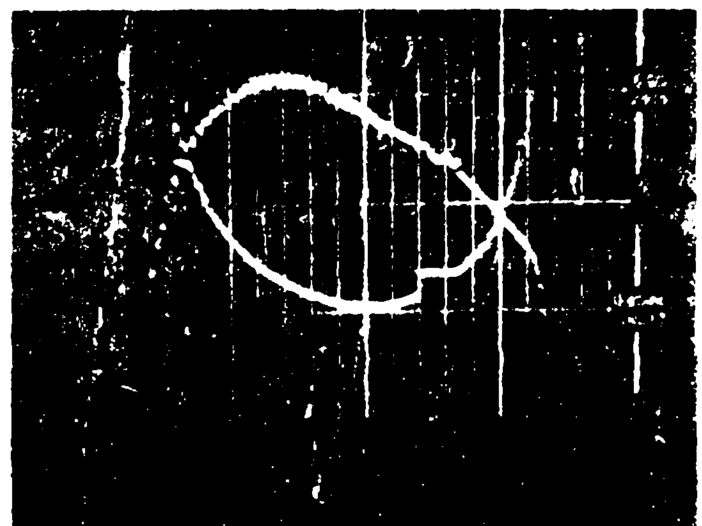


2B03 (A)

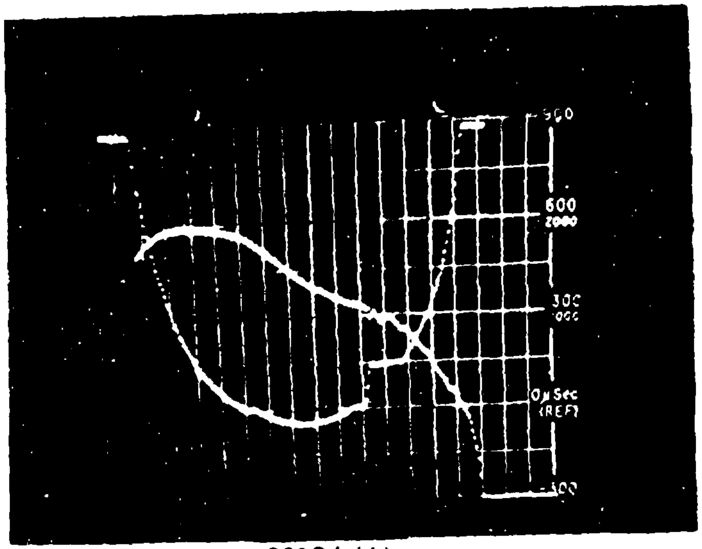
2B03 (B)



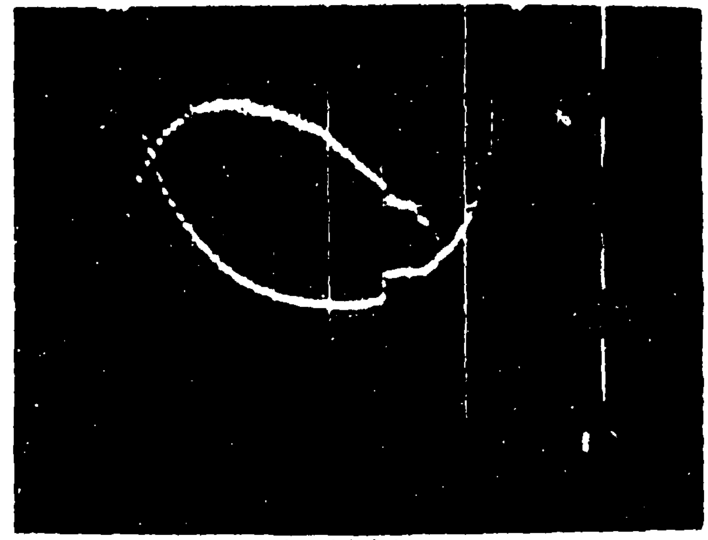
12B04 (B)



26B04 (B)

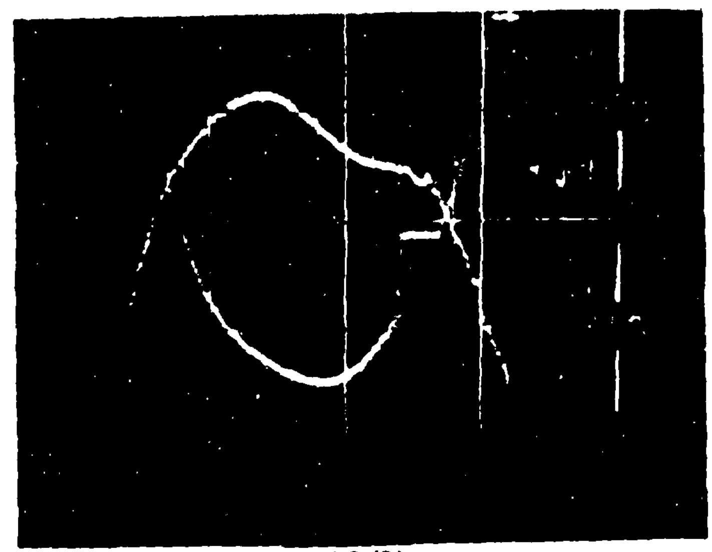


29B04 (A)

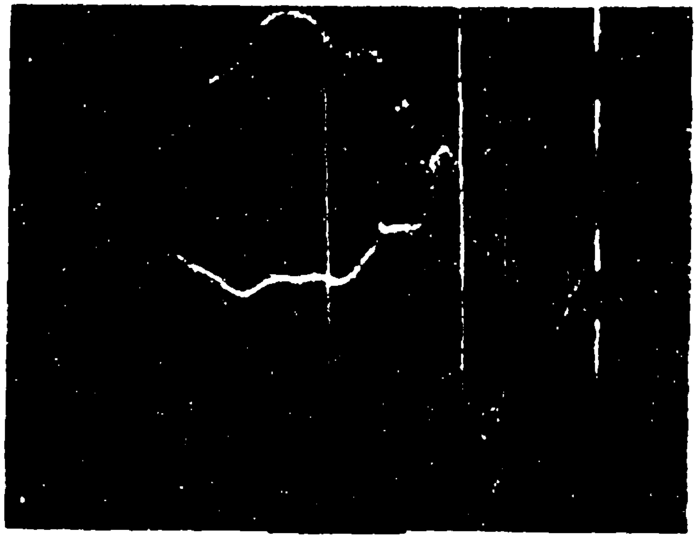


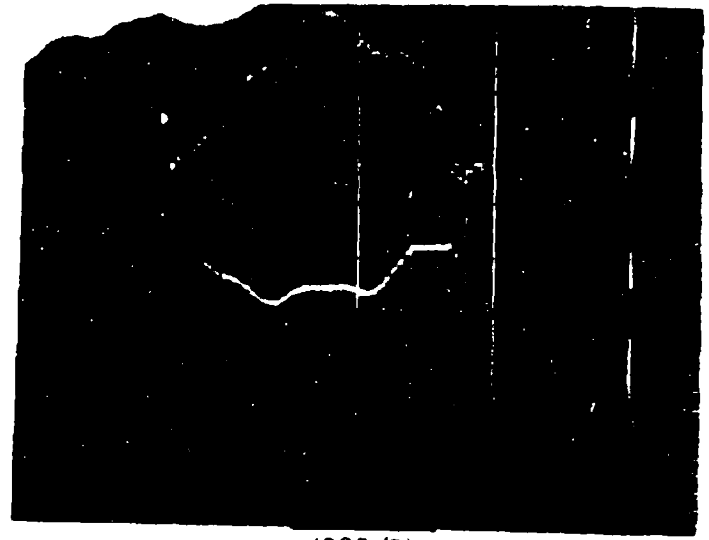
31B04 (B)

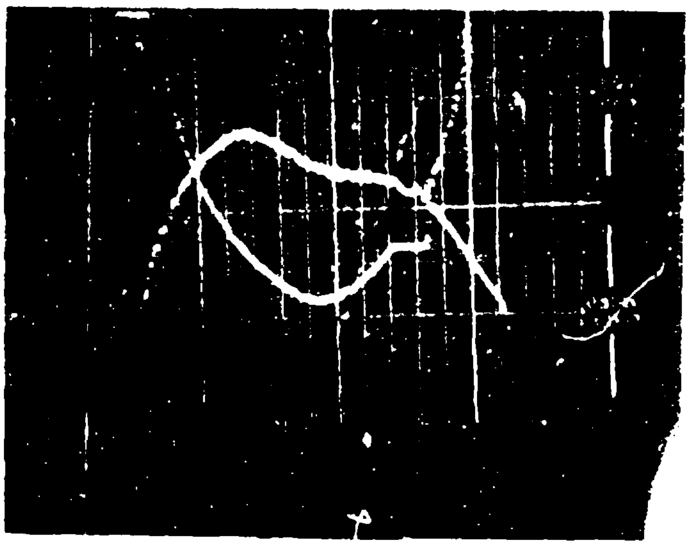
35B04 (B)

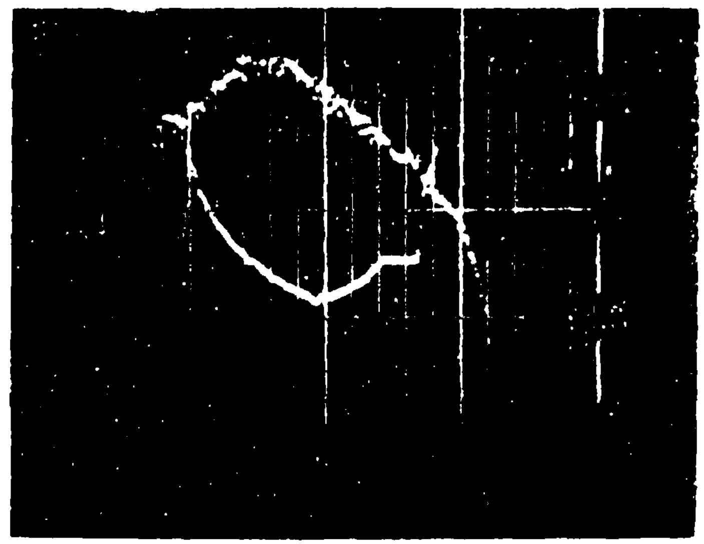


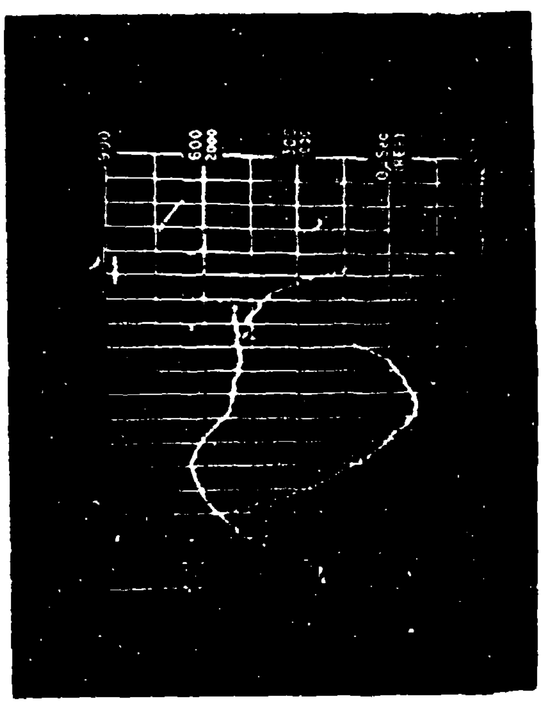
3B05 (B)


5B05 (B)

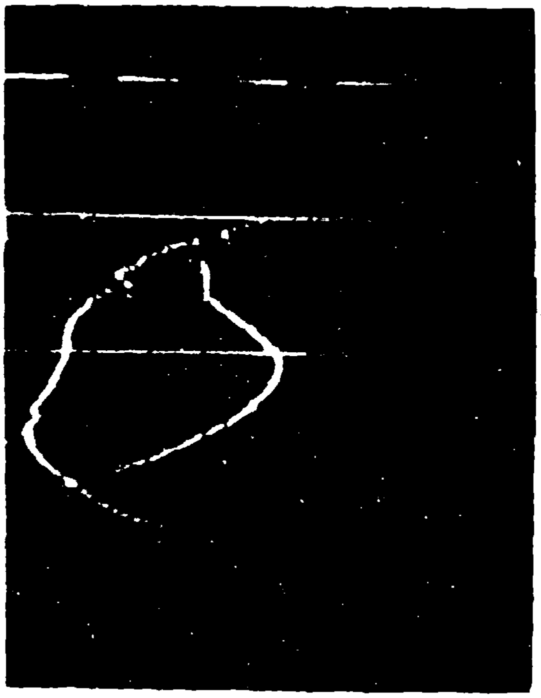

6B05 (B)


7B05 (B)

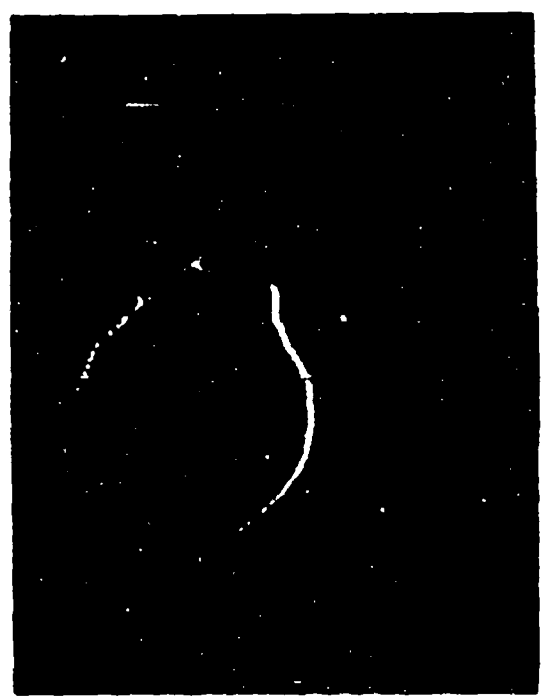

9B05 (B)



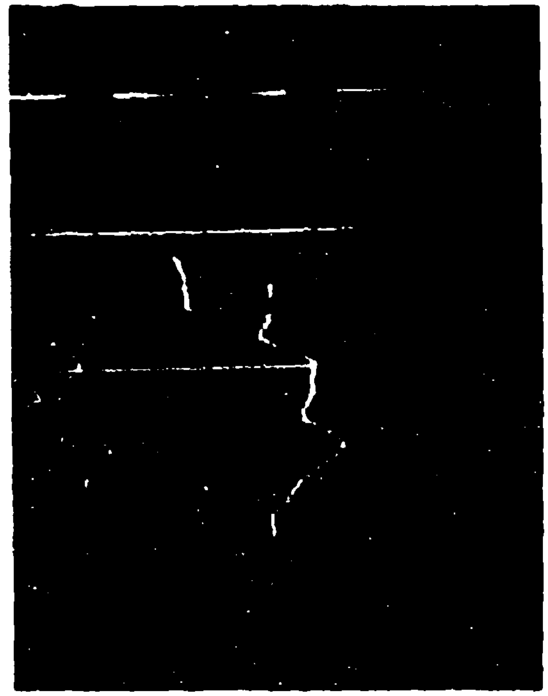
10B05 (A)



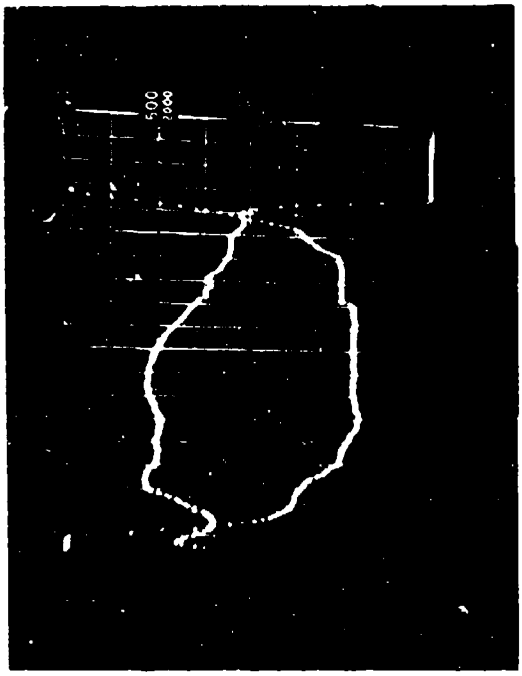
10B05 (B)



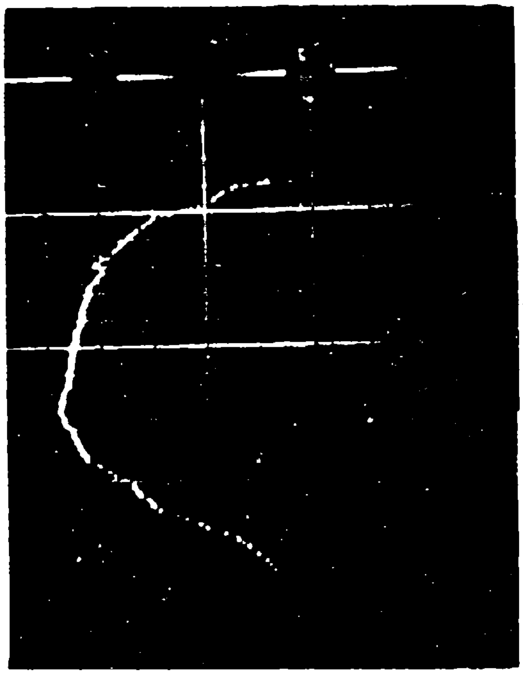
2B06 (B)



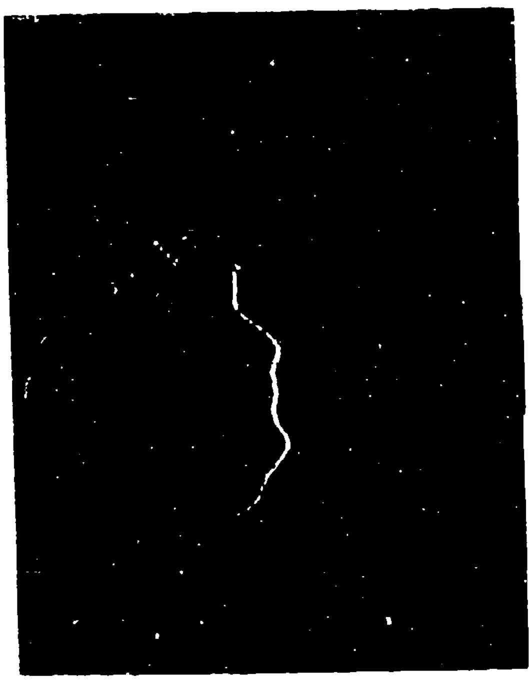
3B06 (B)



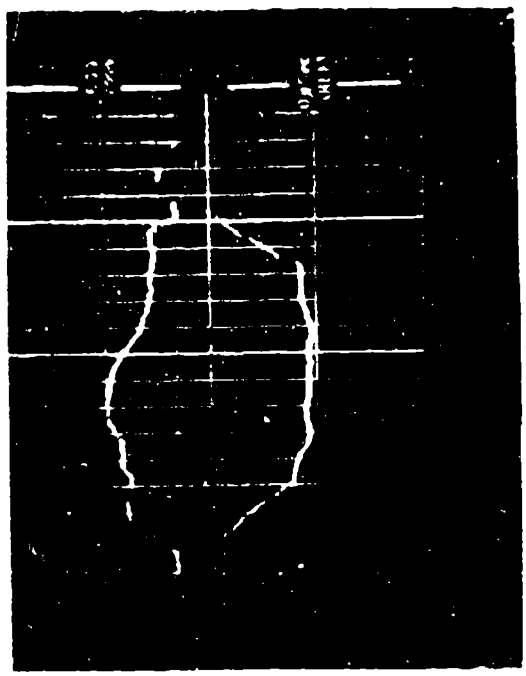
10A07 (A)



12A07 (B)



5806 (B)



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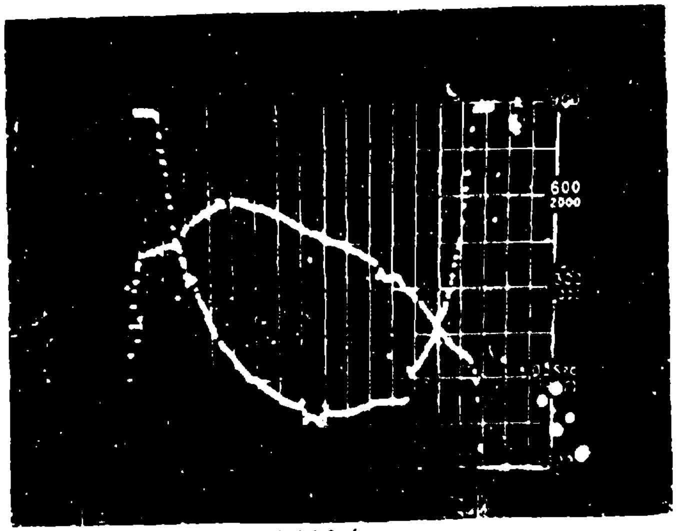
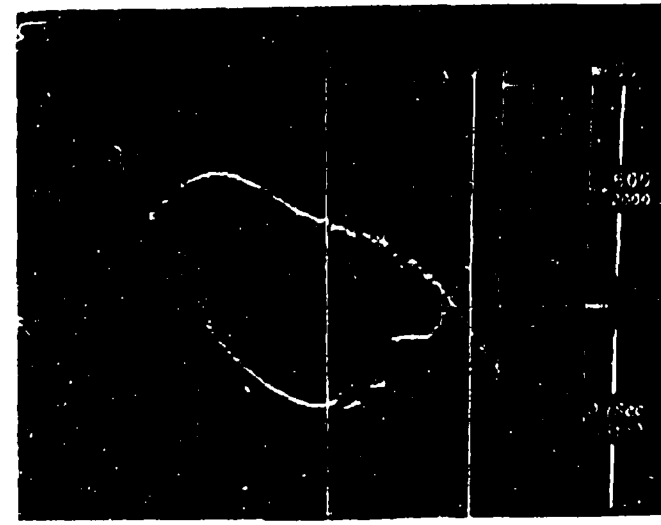
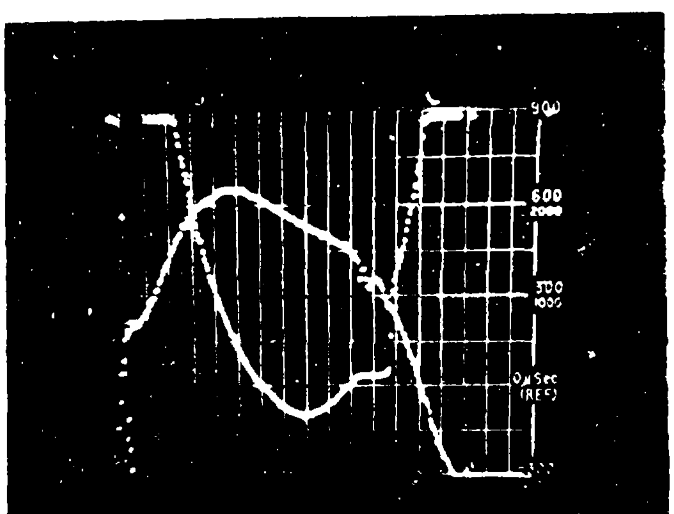


2A10 (A)

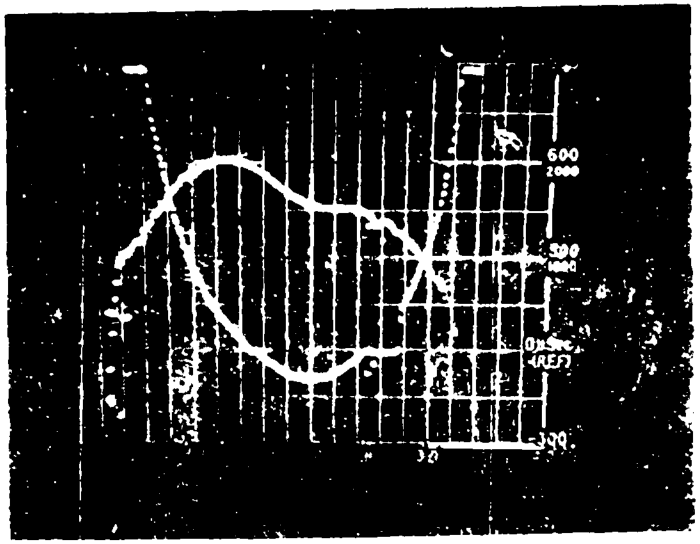


2B10 (B)

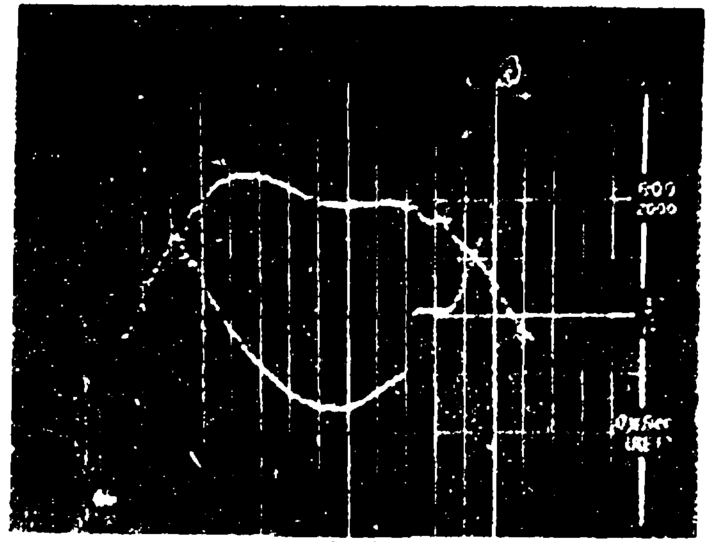


9A10 (A)

9B10 (B)



1B11 (A)



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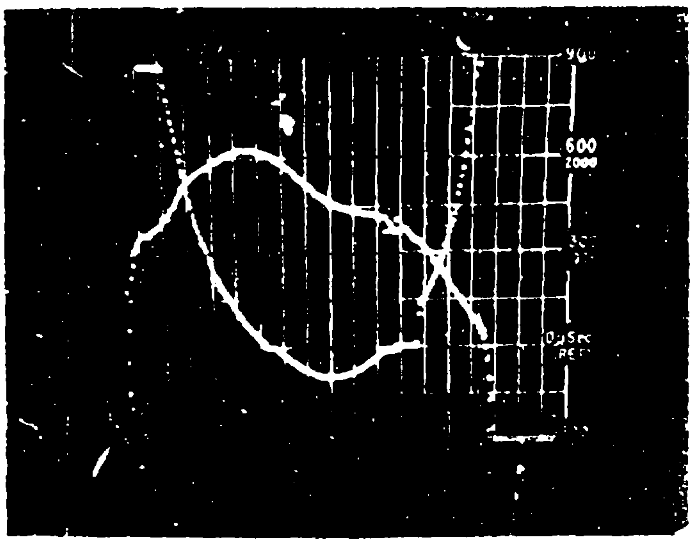
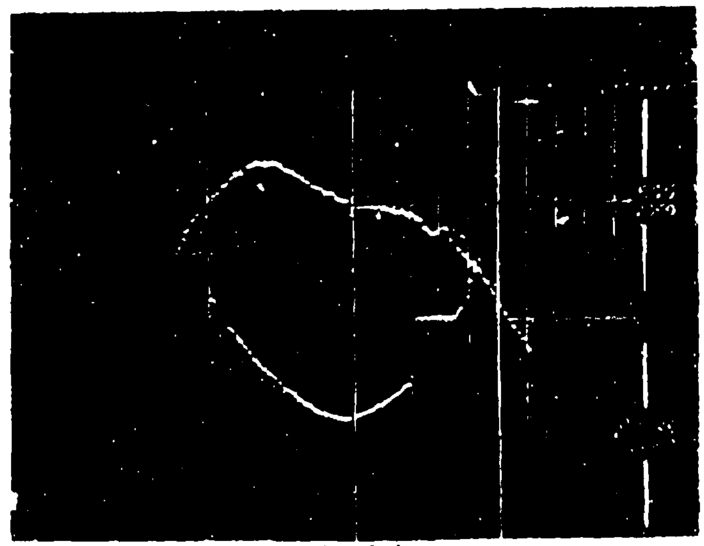
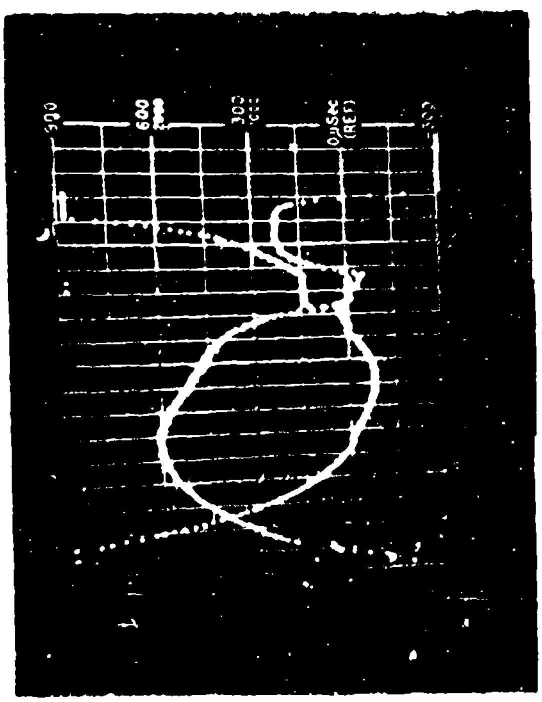


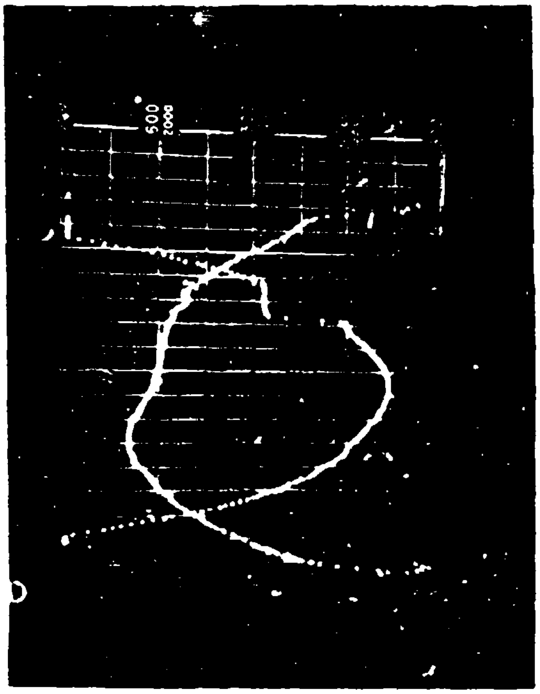
18B11 (A)



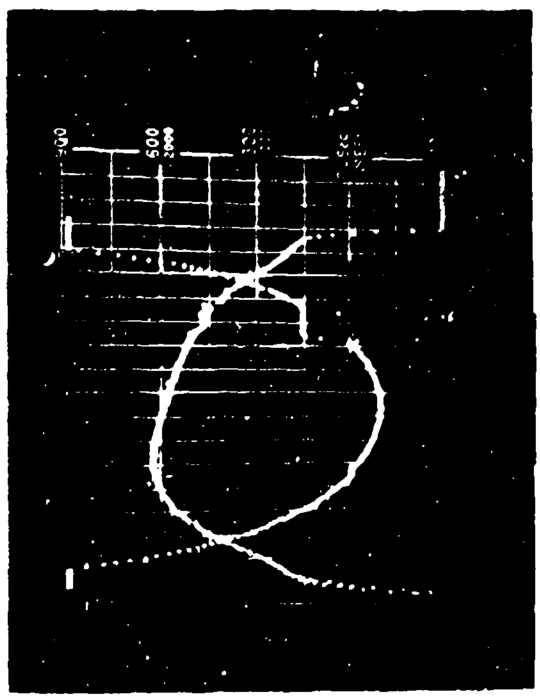
18B11 (B)



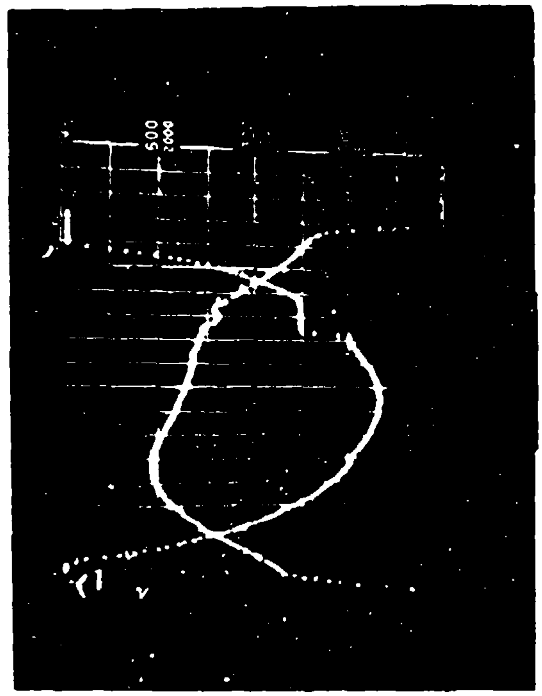
4A12 (A)



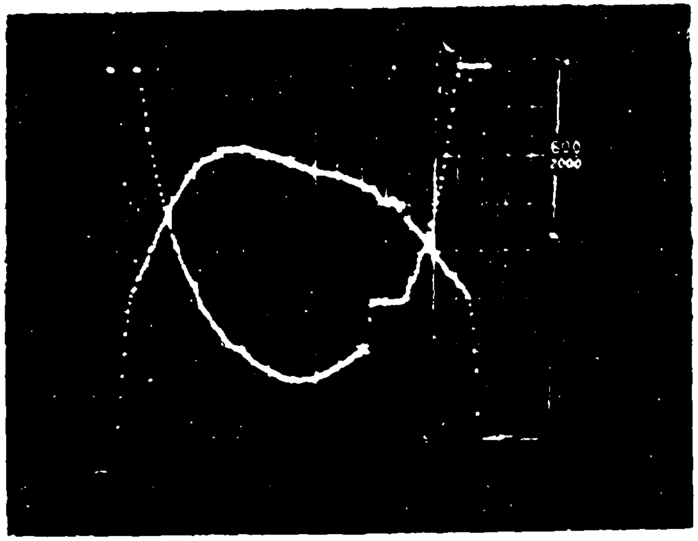
8A12 (A)



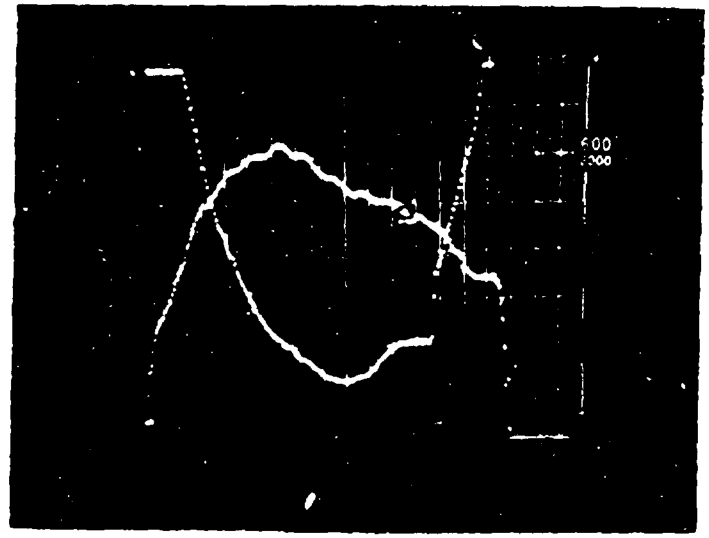
9A12 (A)



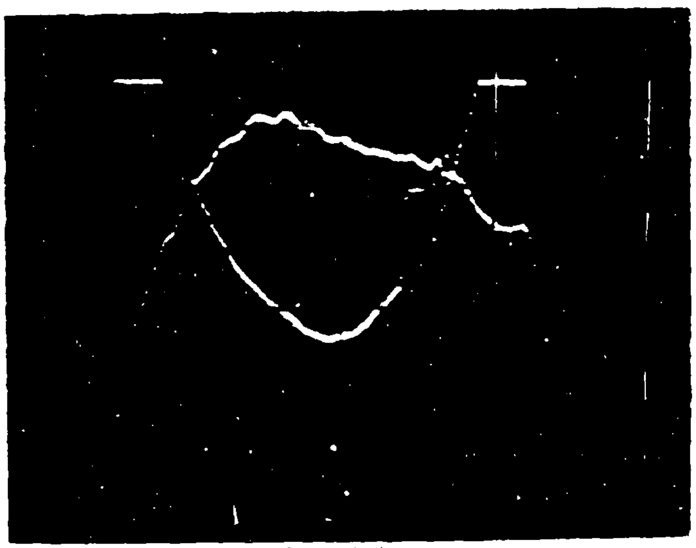
11A12 (A)



13A12



14A12 (A)



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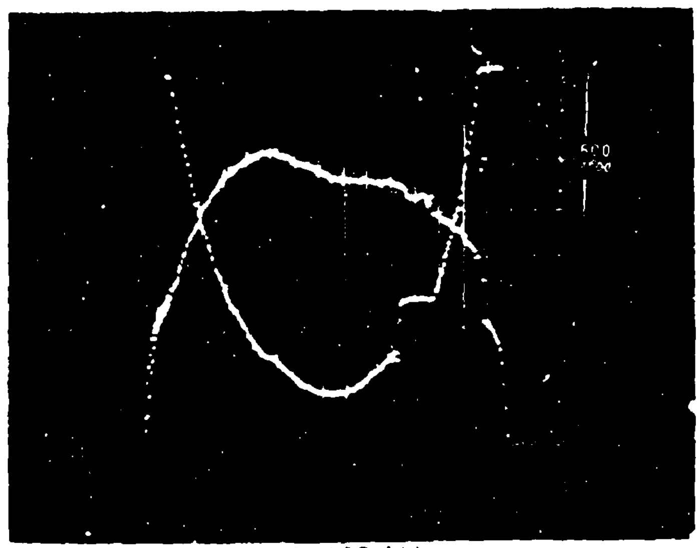
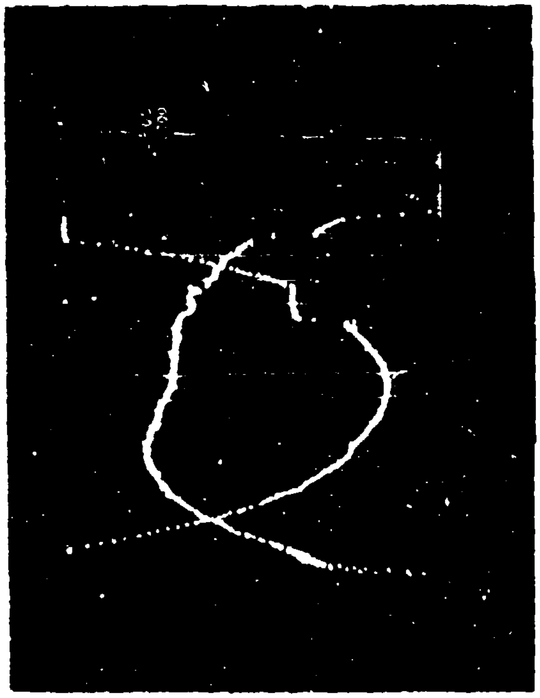
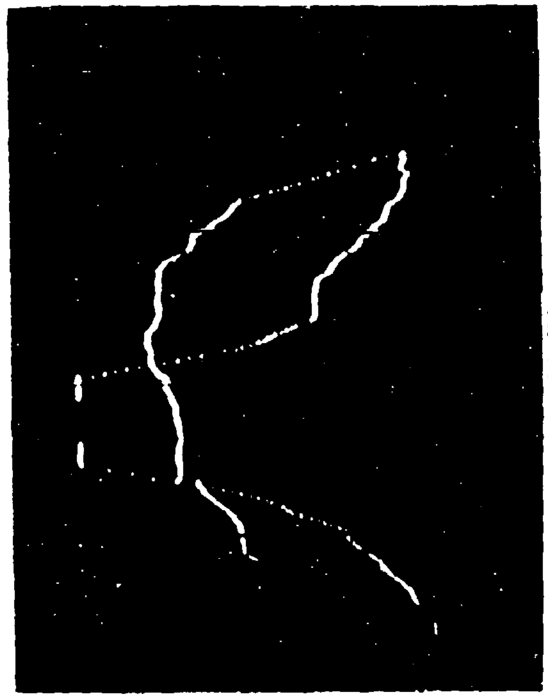


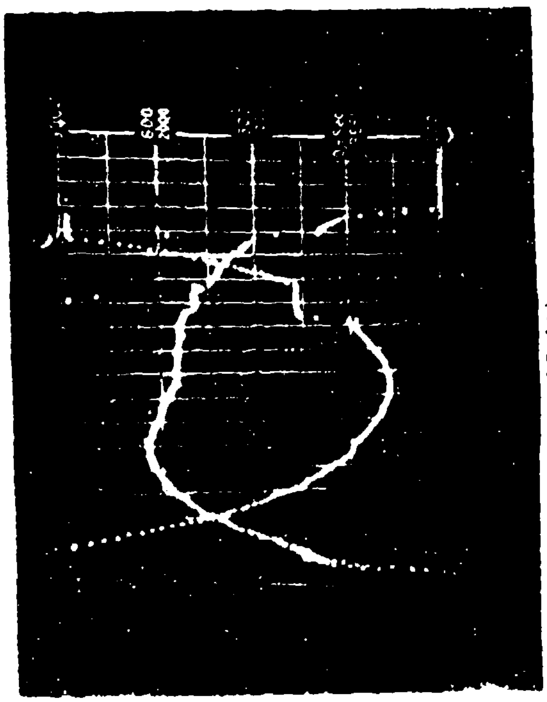
16A12 (A)



18A12 (A)



19A12 (B)



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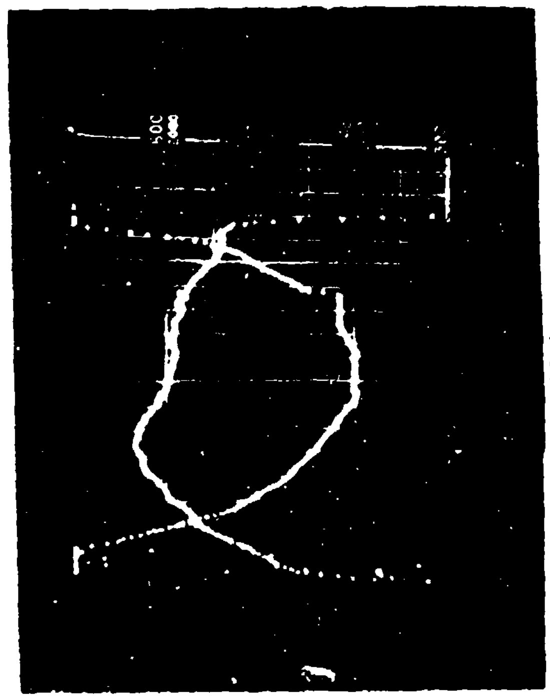
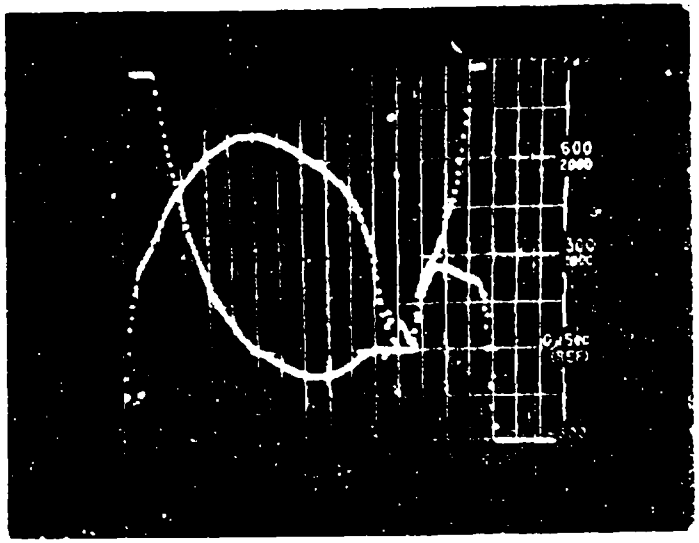
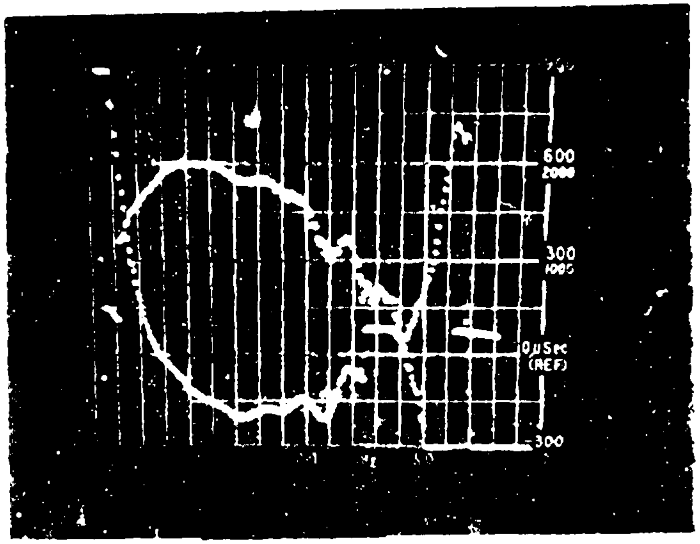


19A12 (A)

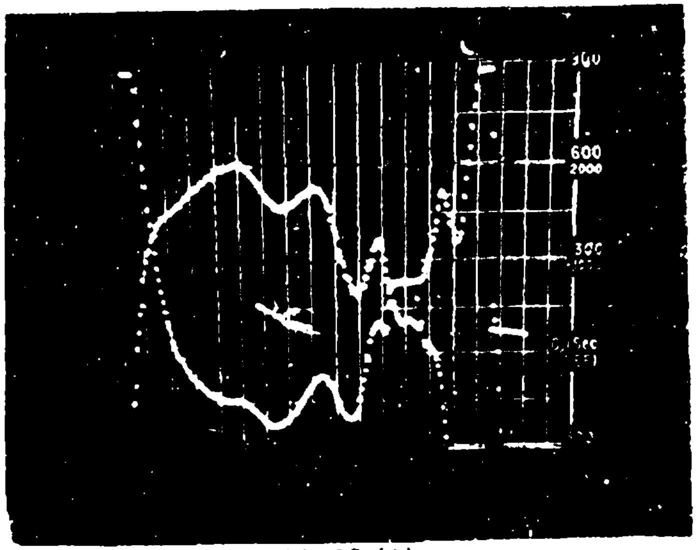


20A12 (A



11A13 (A)

11A13 (B)



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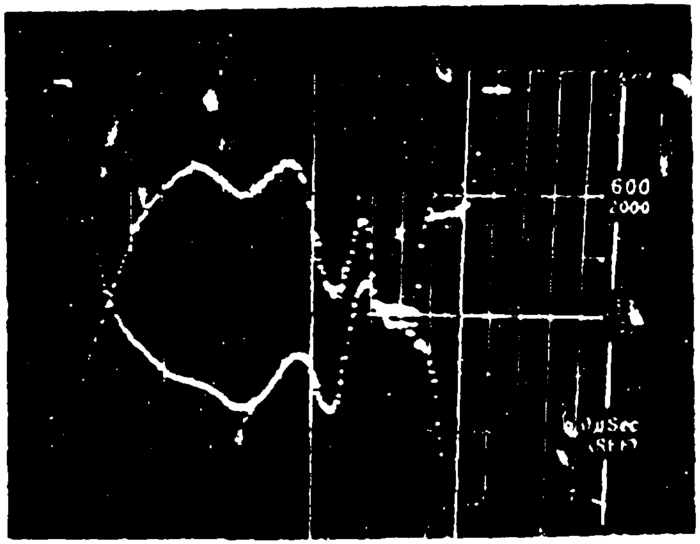
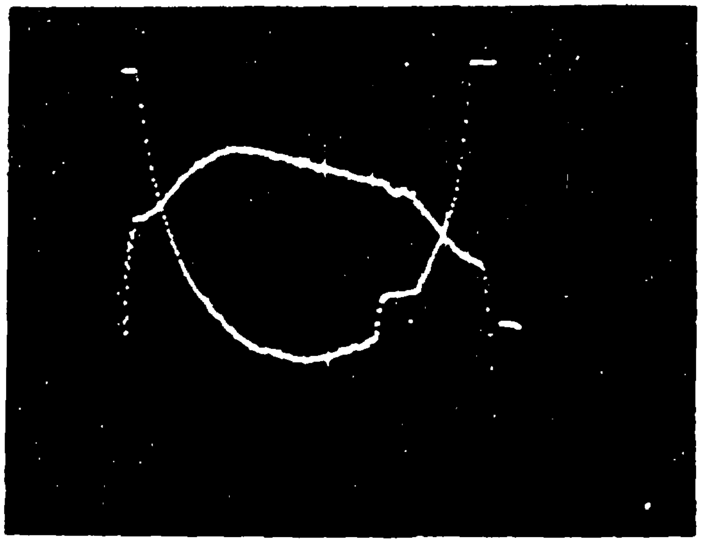
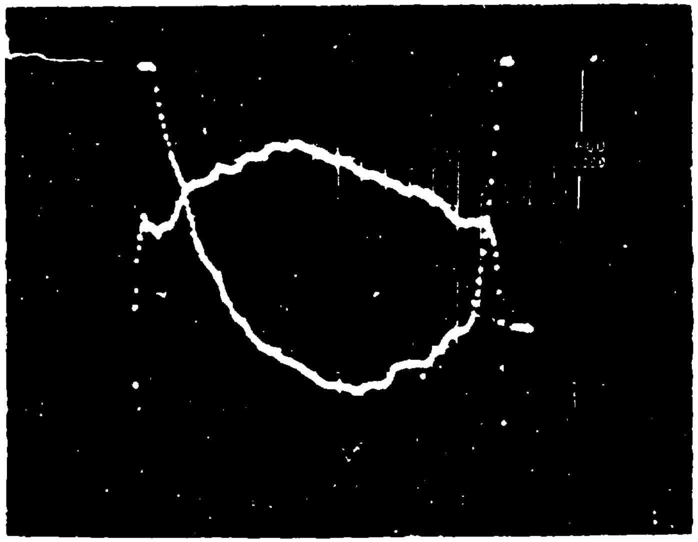


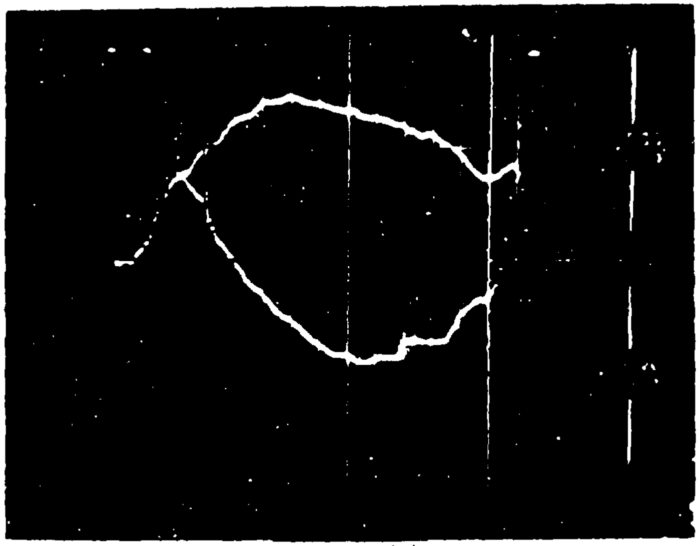
12A13 (B)



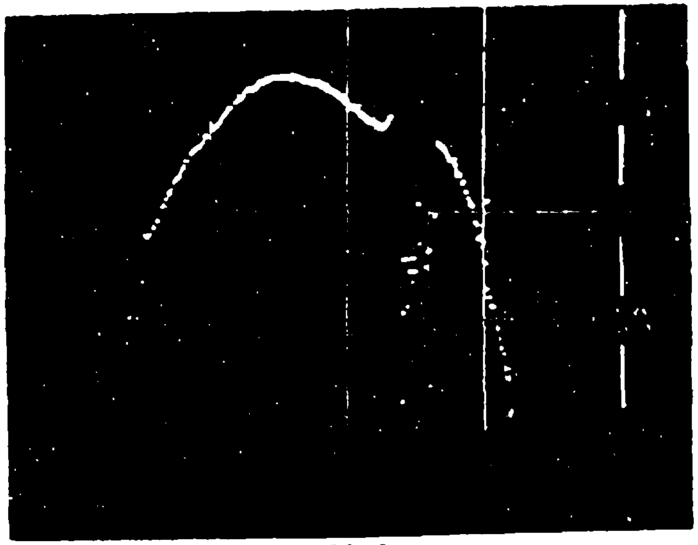
30B13 (A)



31B13 (A)



31B13 (B)



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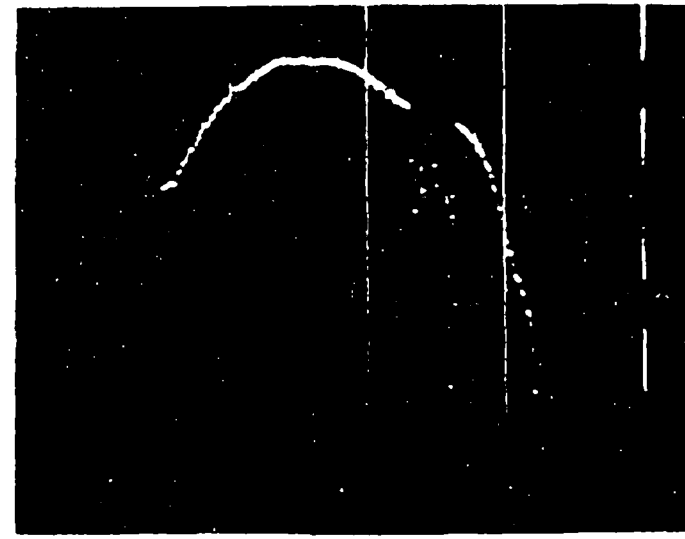

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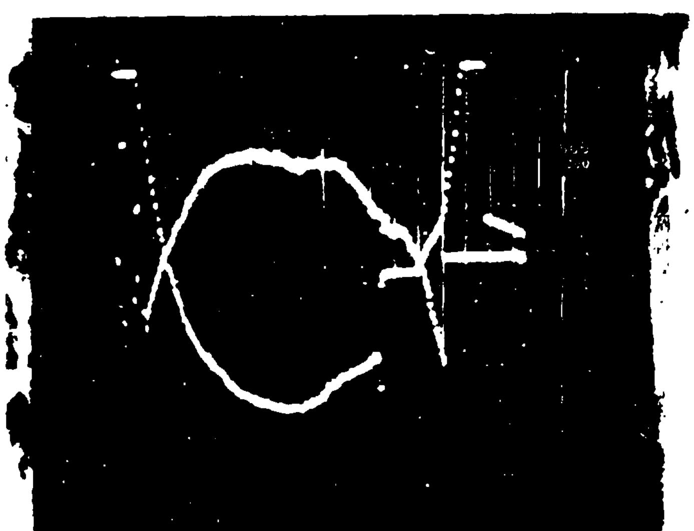
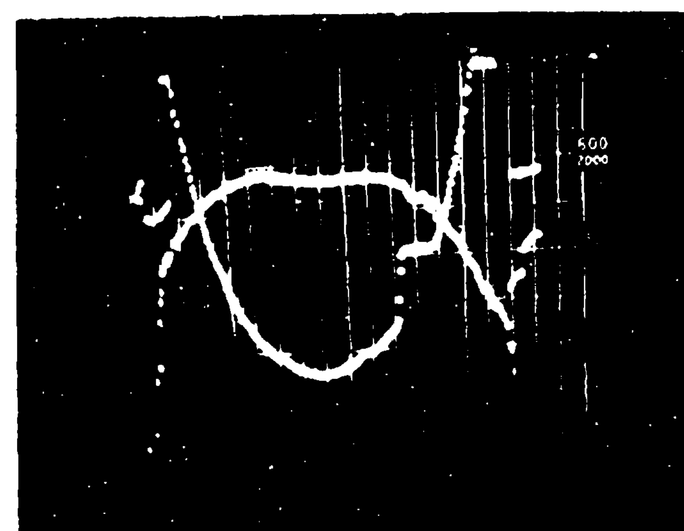
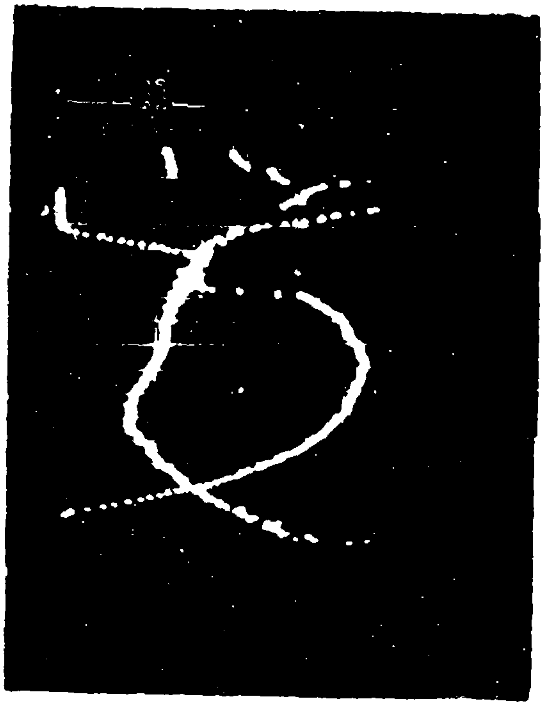
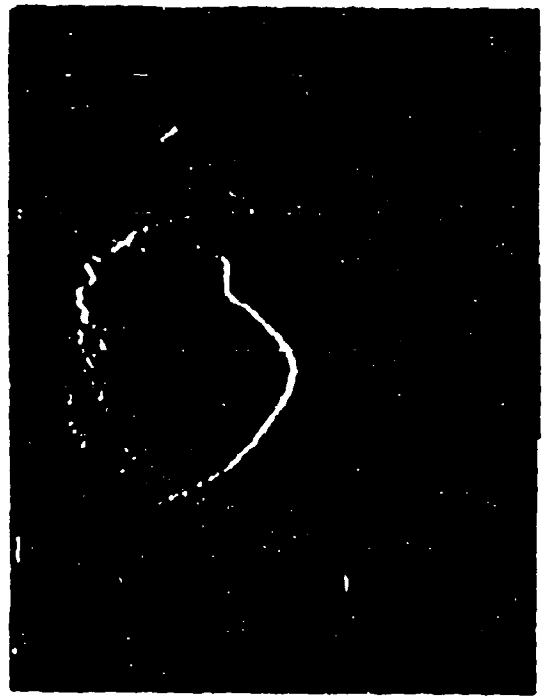


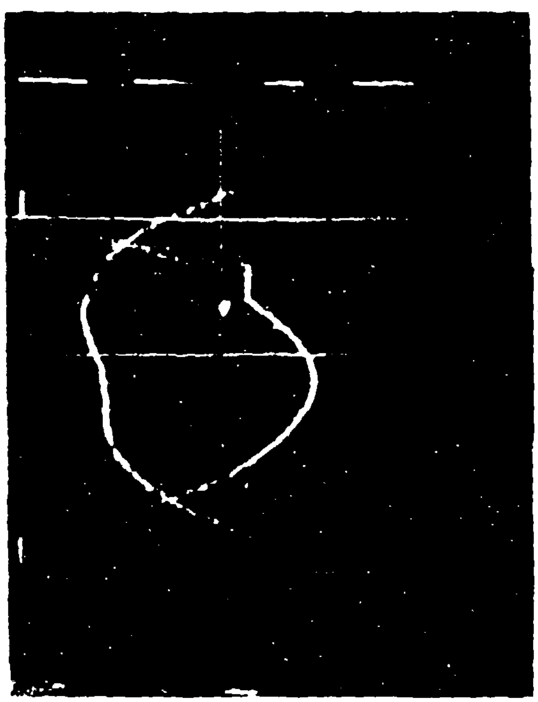
102B19 (A

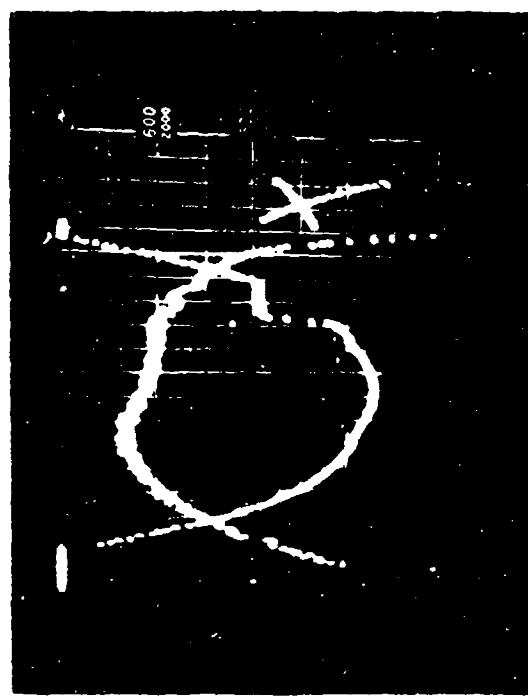


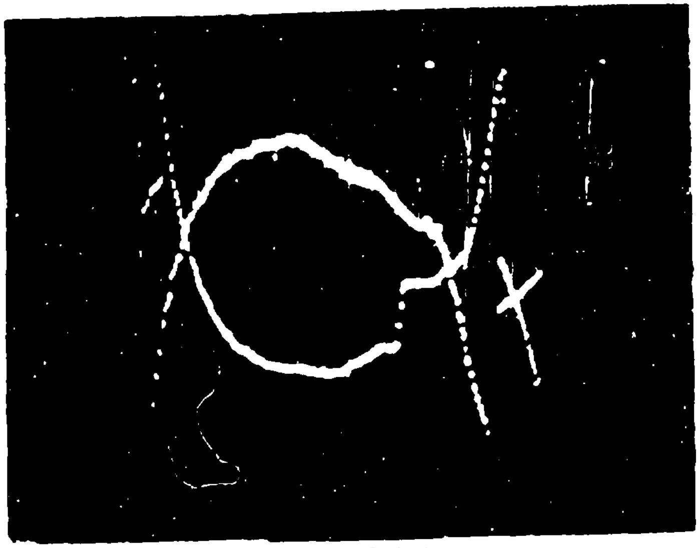
106A20 (A)


109A20 (A)

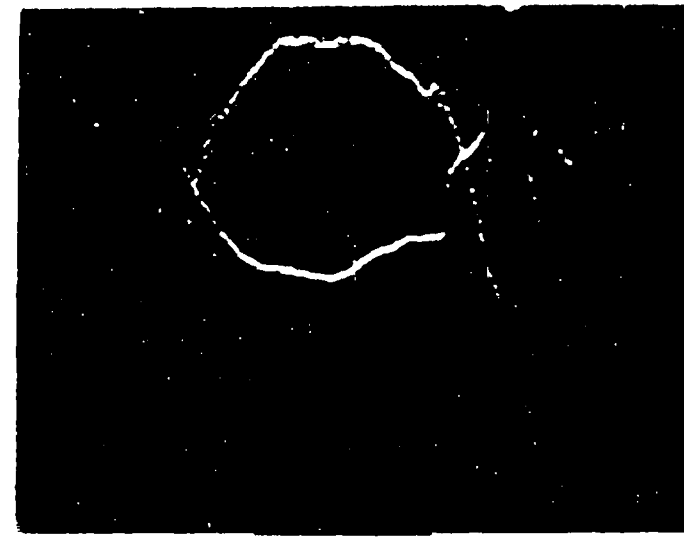

110A20 (B)


106A20 (B)

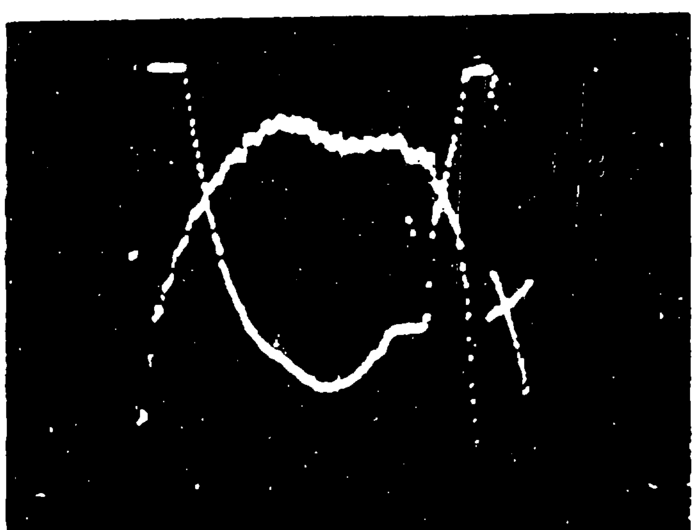

110A20 (A)



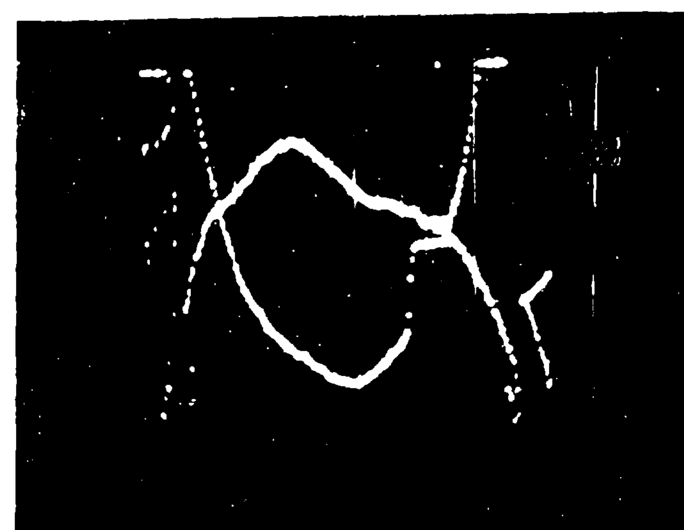
111A20 (A)



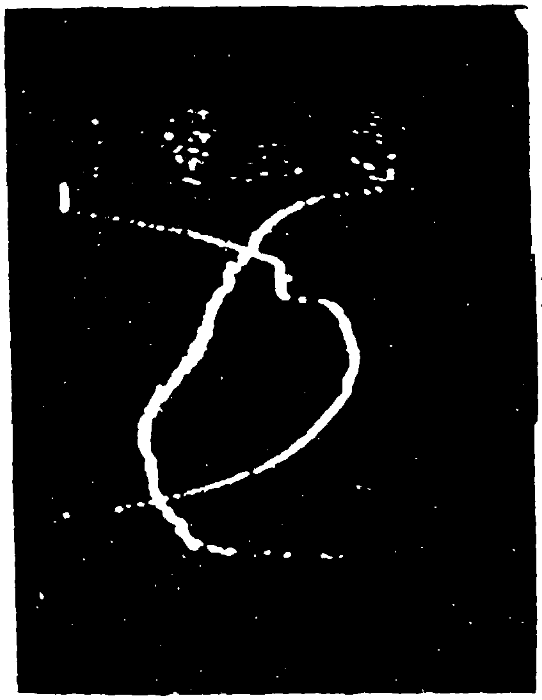
111A20 (B)



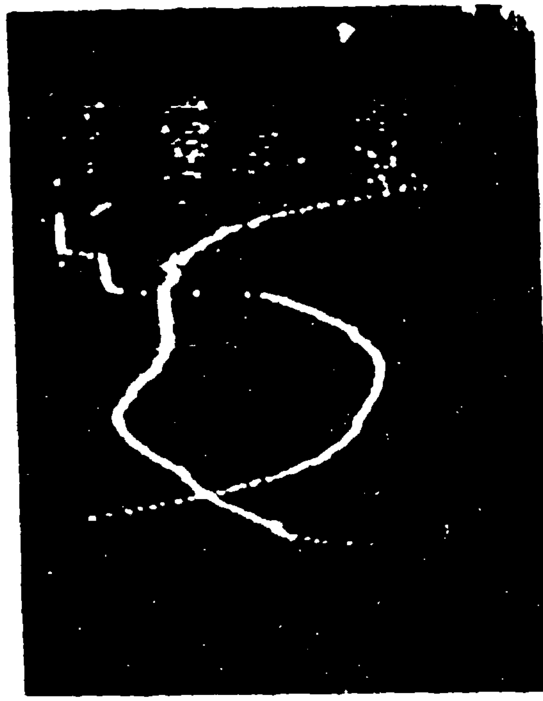
112A20 (A)



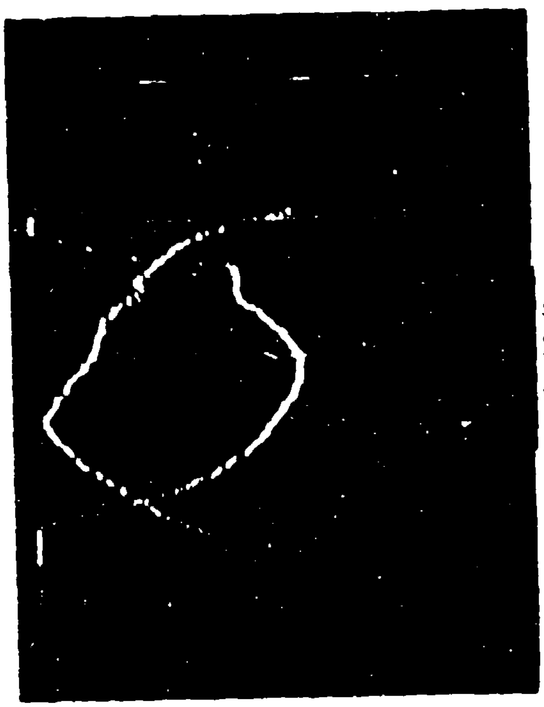
113A20 (A)



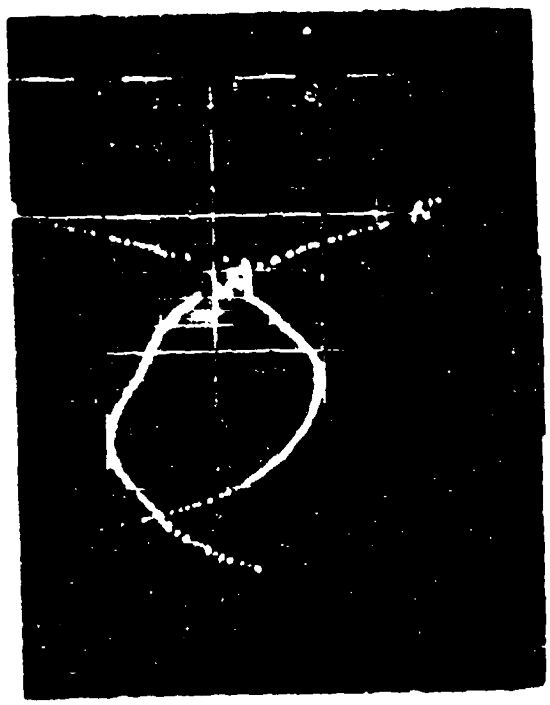
11A21 (A)



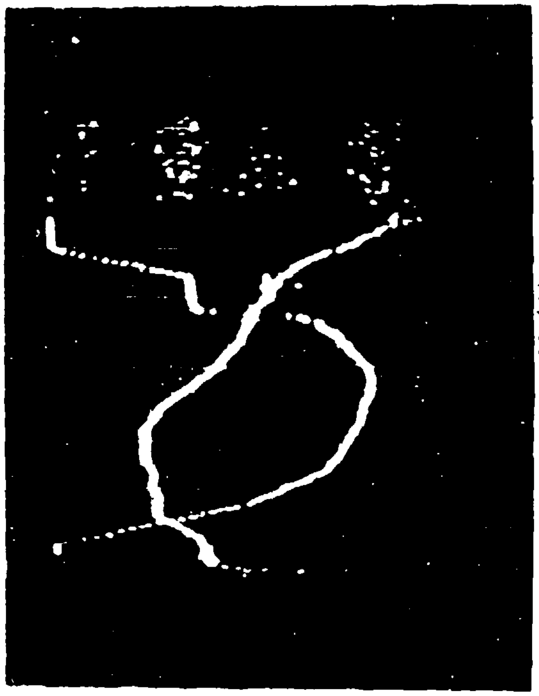
14A21 (A)



113A20 (B)



12A21



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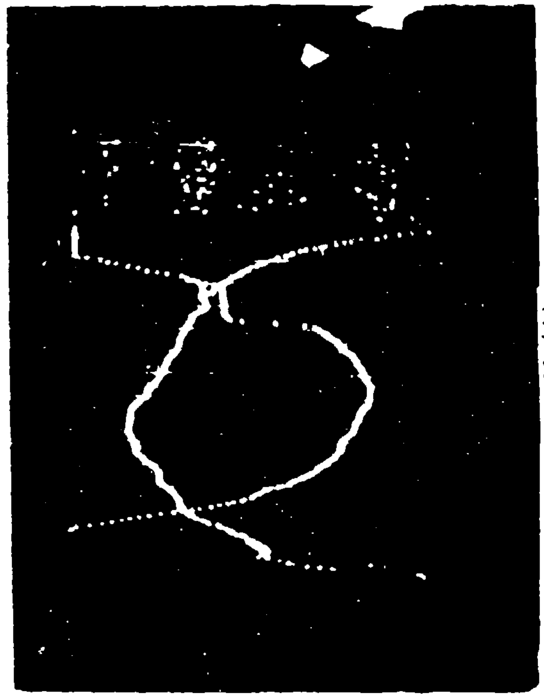
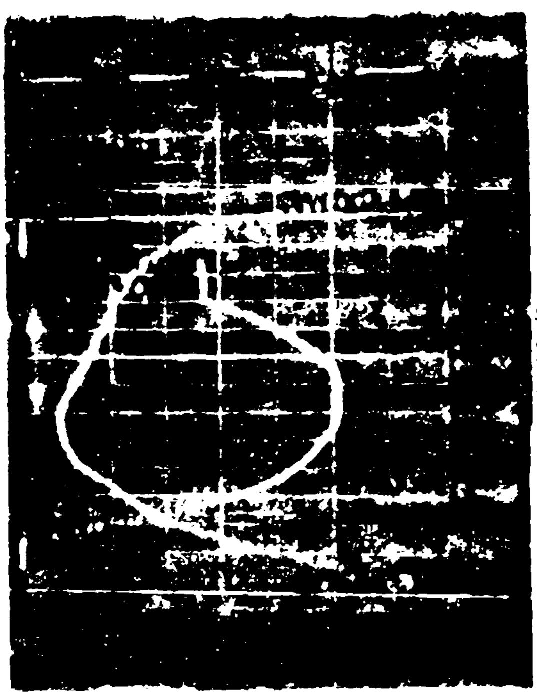
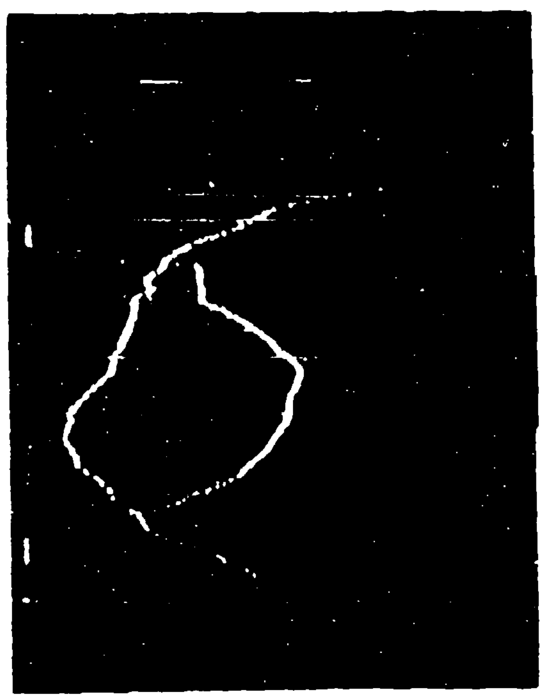


16A21 (A)



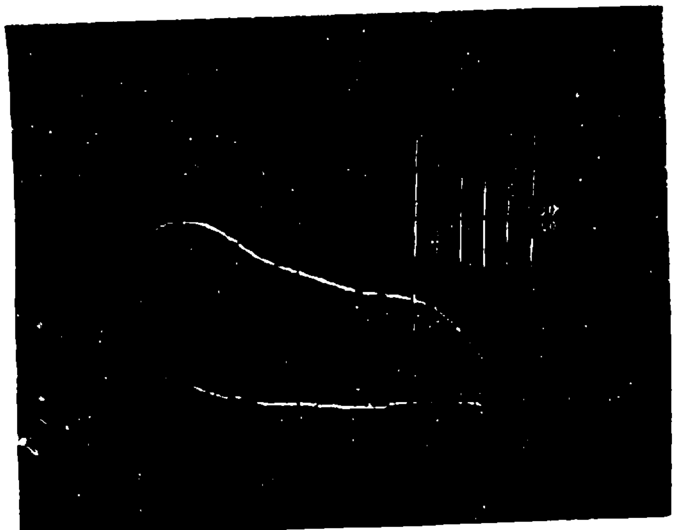
14A21 (B)



15A21 (B)

16A21 (B)

26A21 (B)



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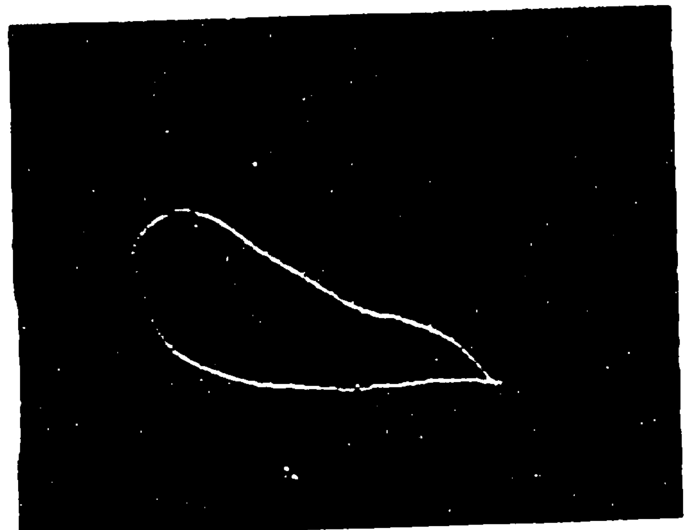

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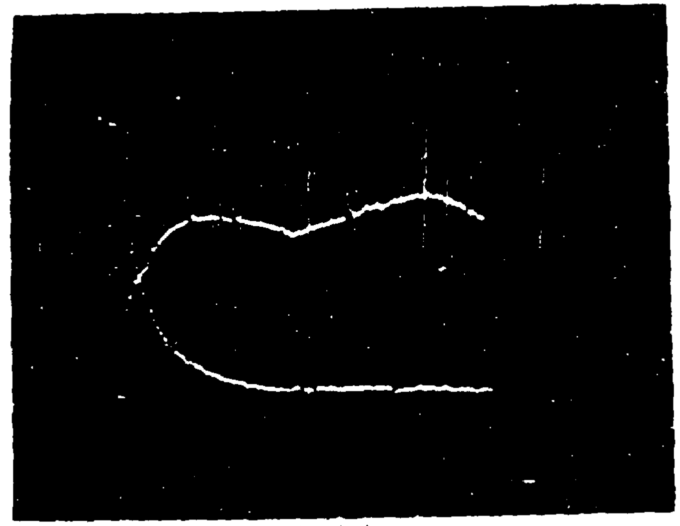
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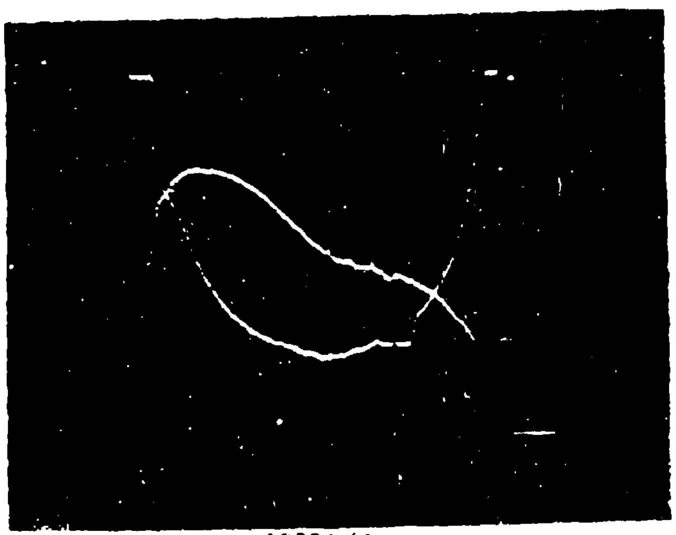
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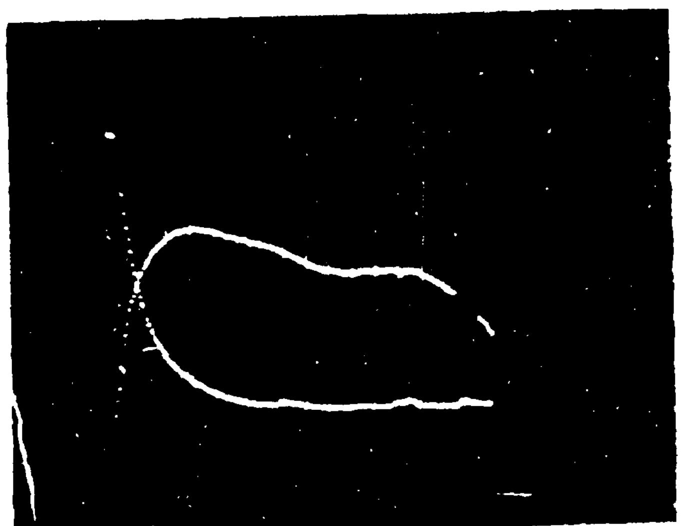
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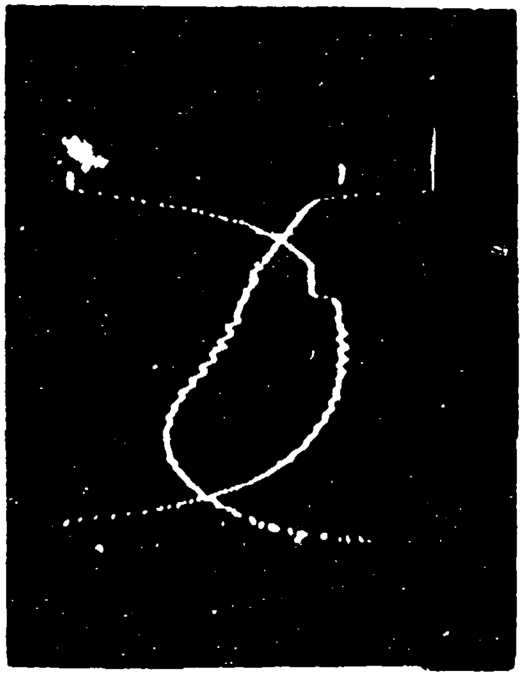
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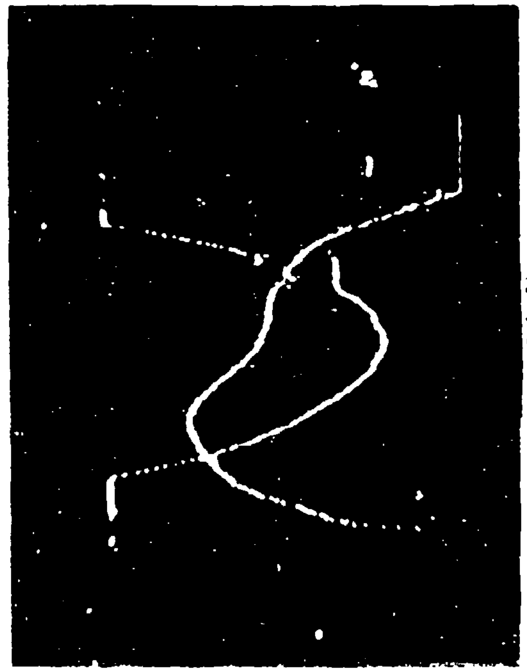
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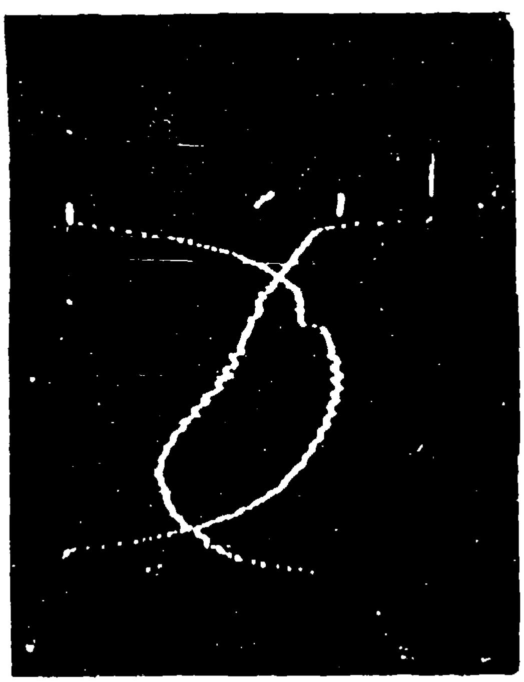
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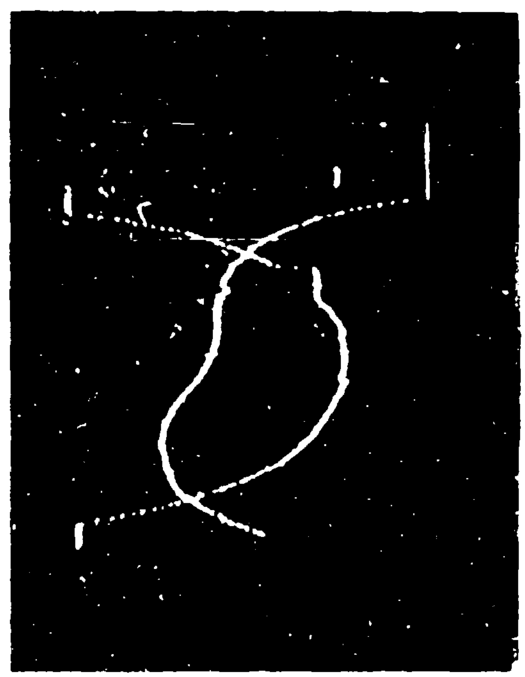
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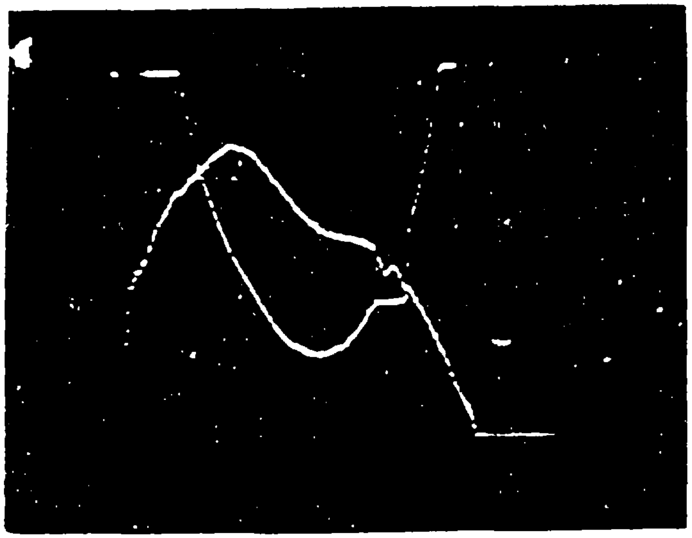
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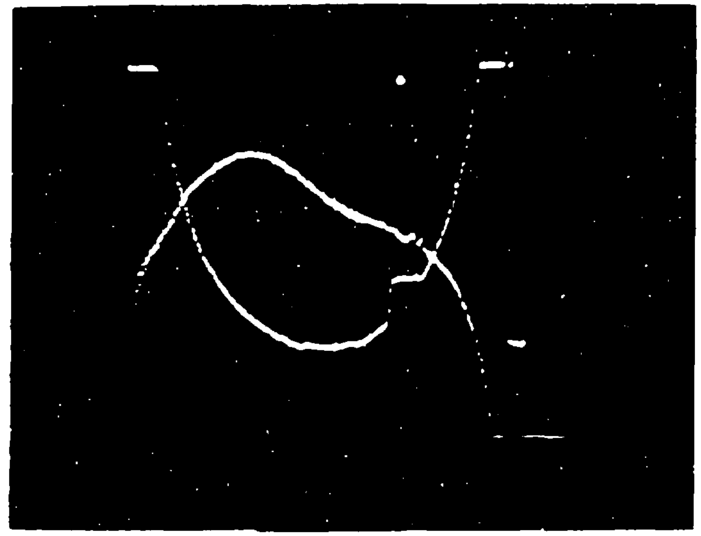
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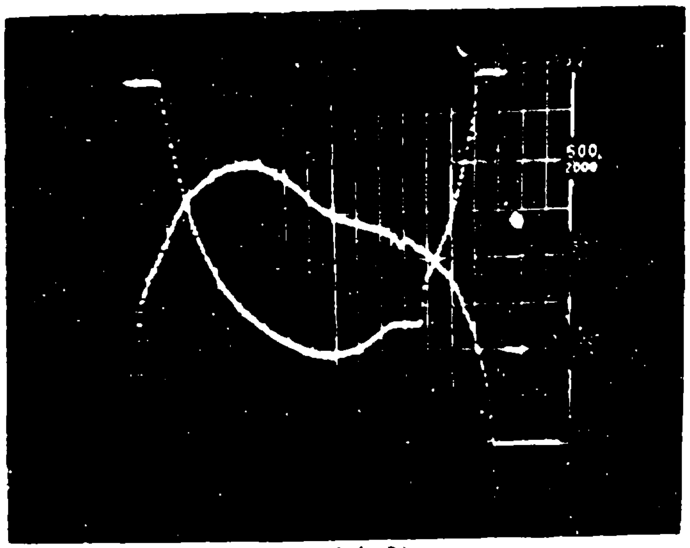

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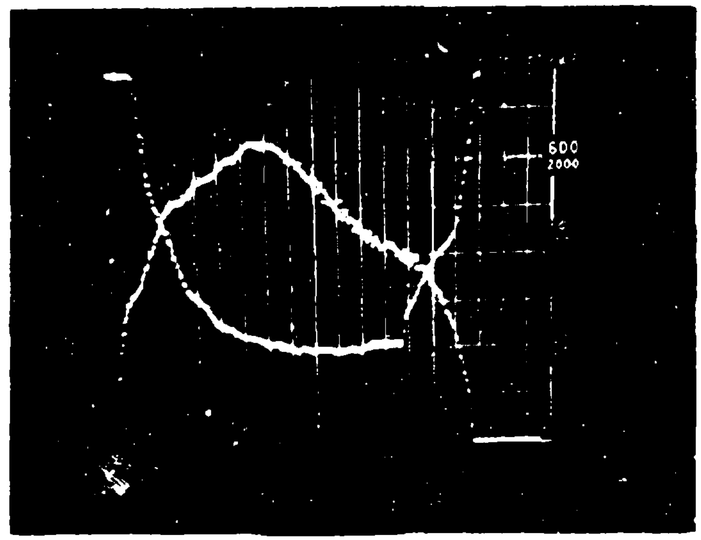

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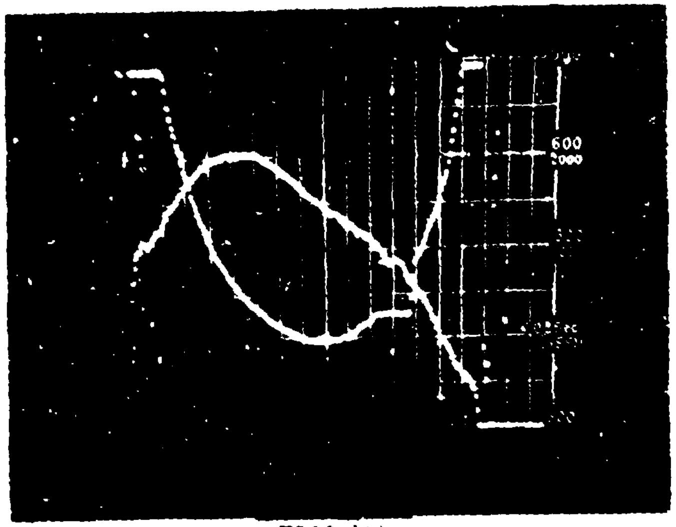

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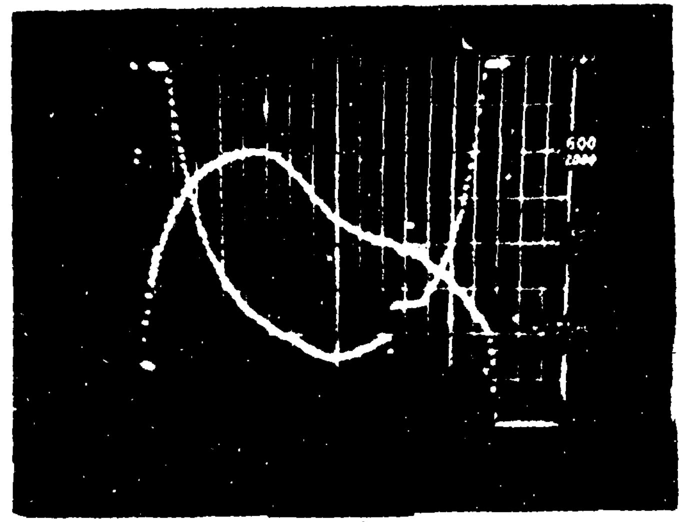

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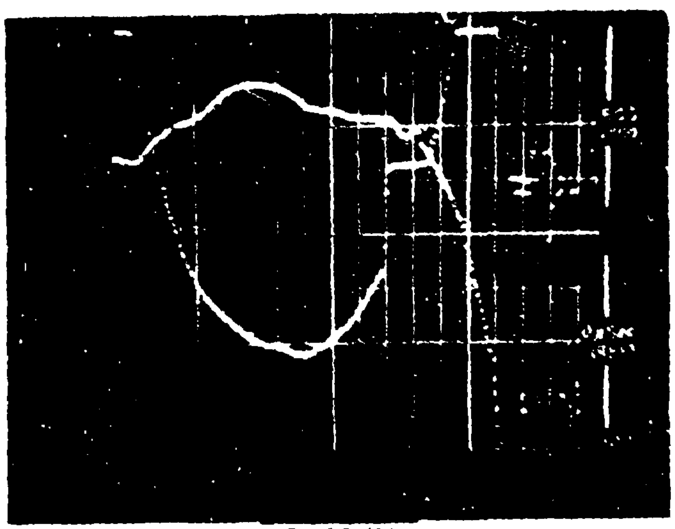

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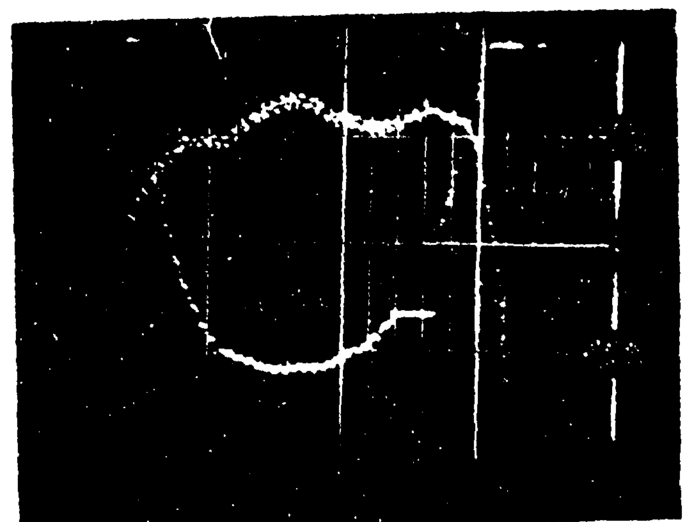

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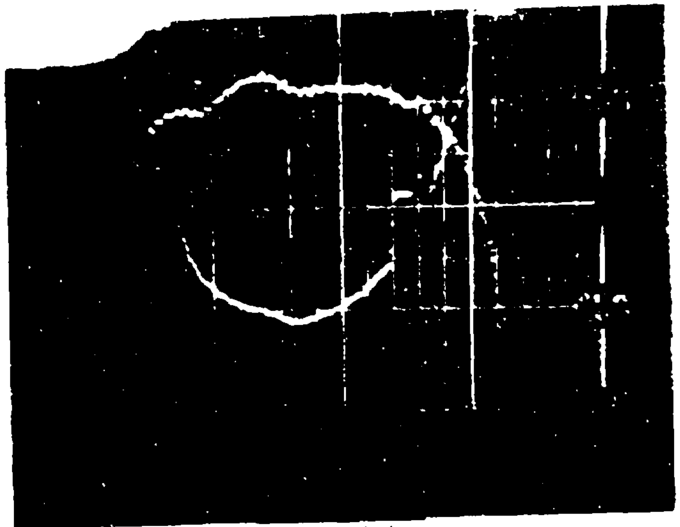

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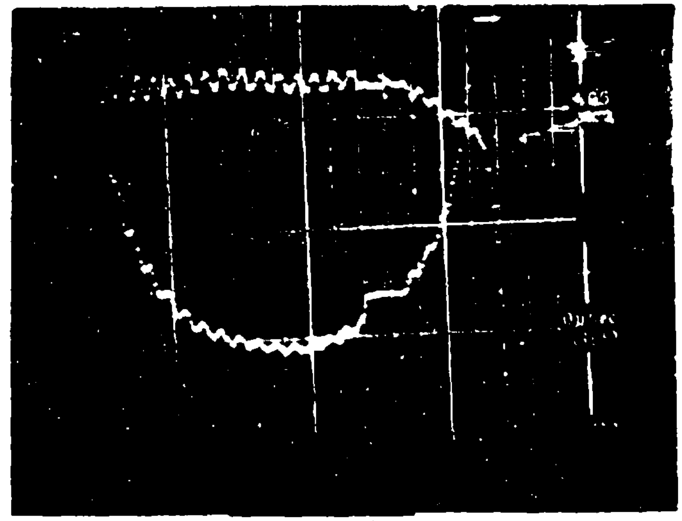

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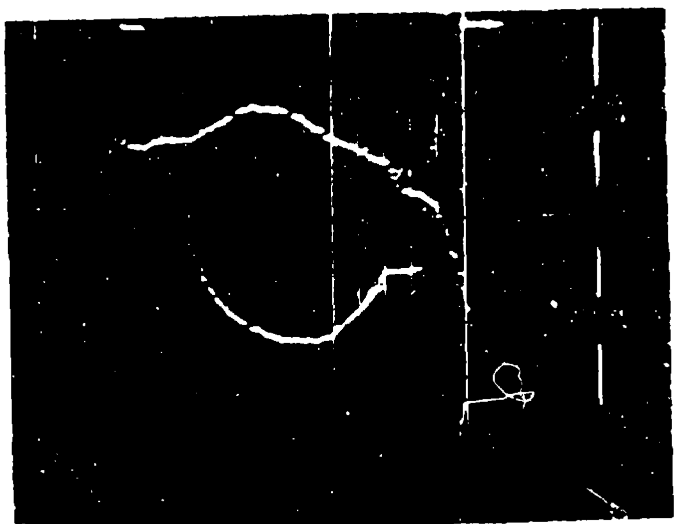

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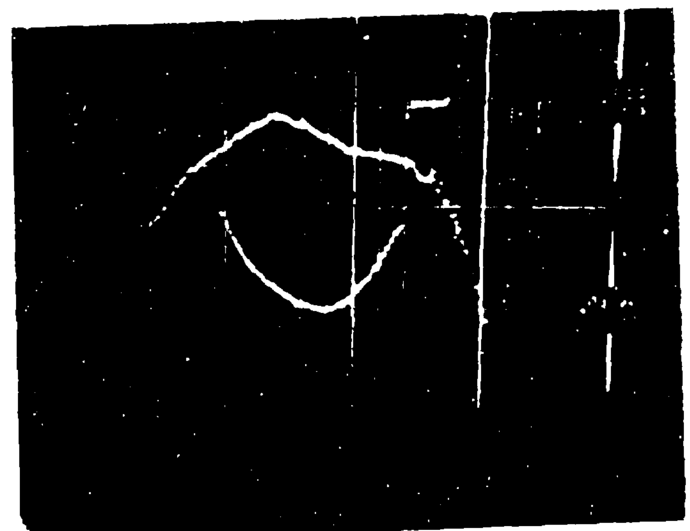

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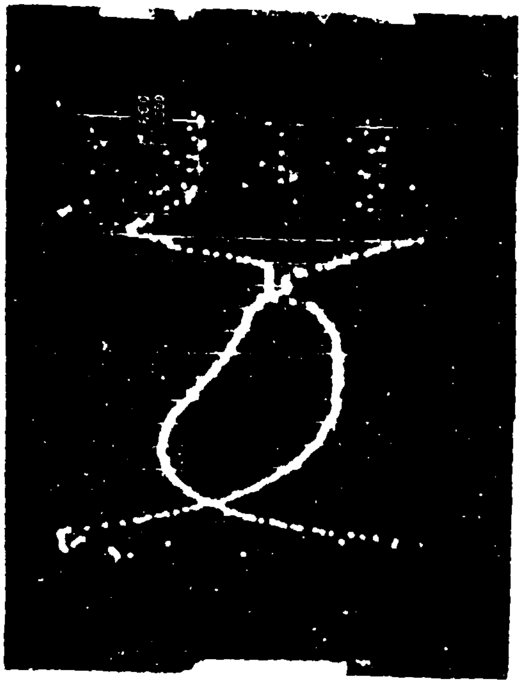

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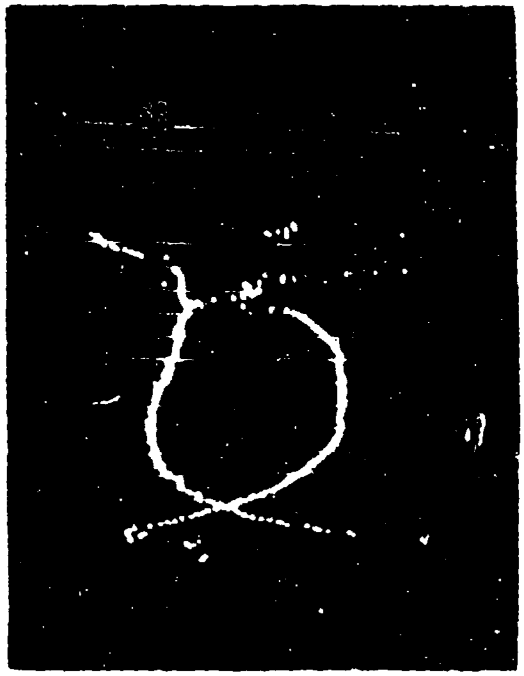

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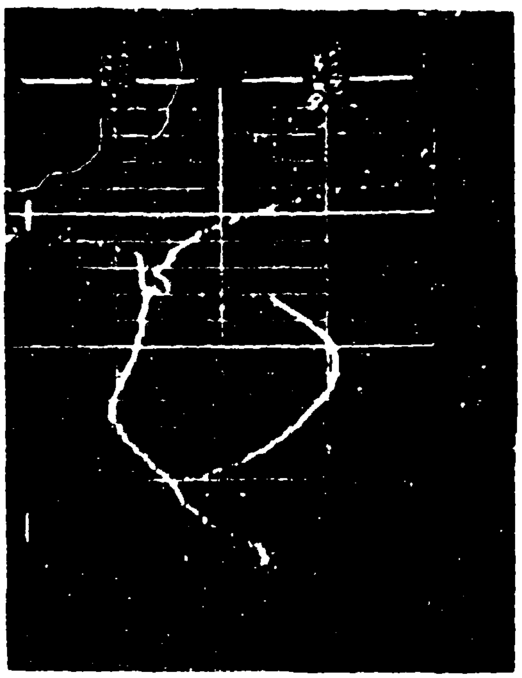

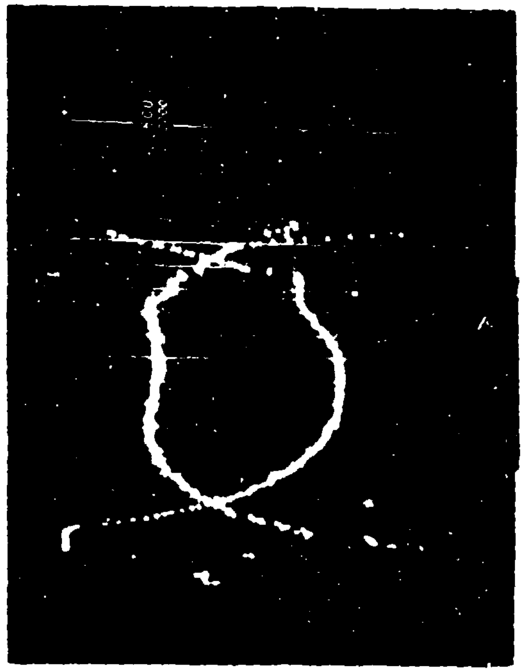

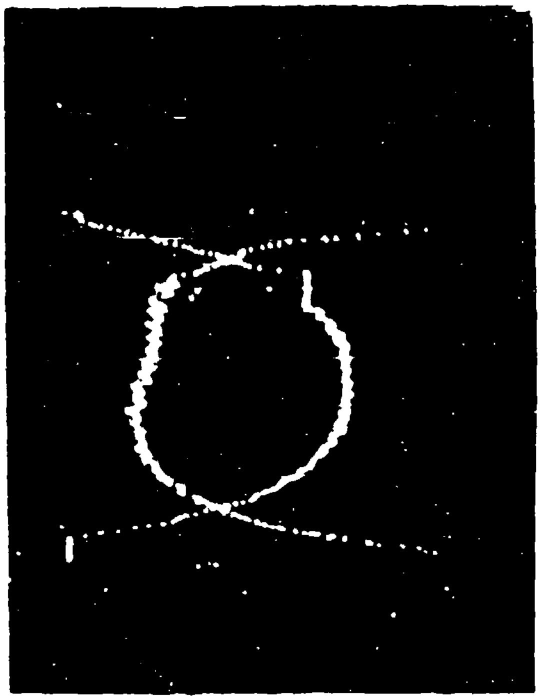

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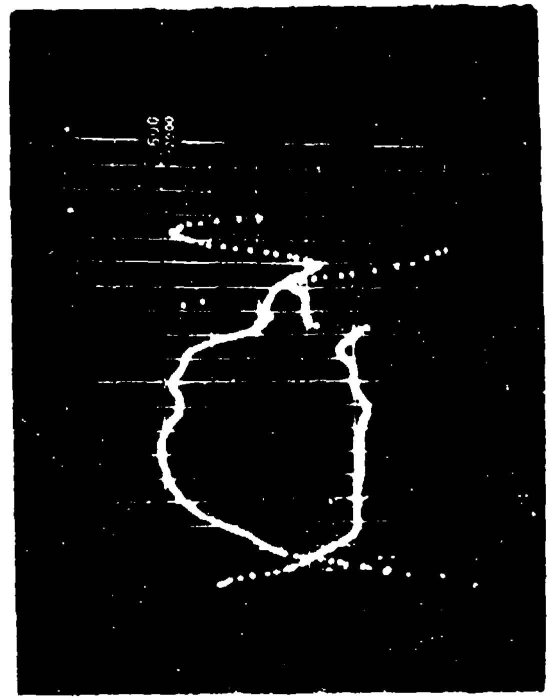

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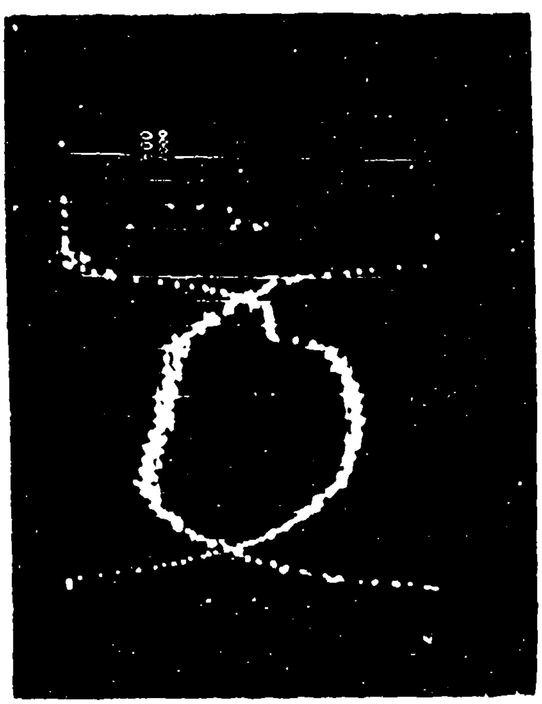

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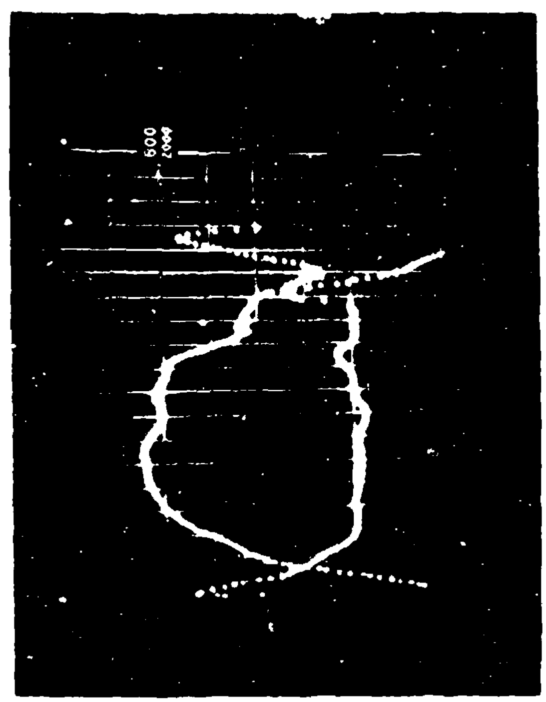

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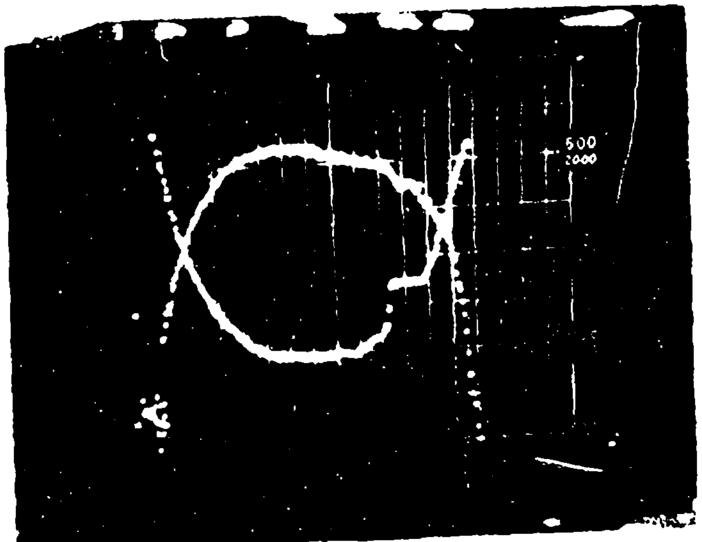

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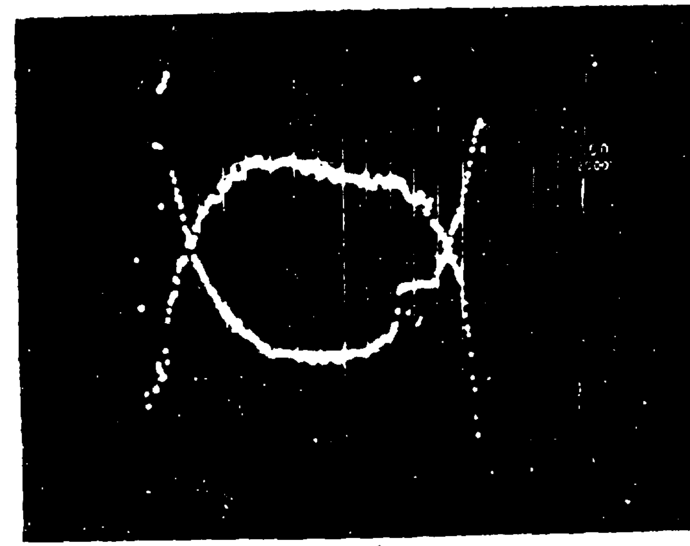

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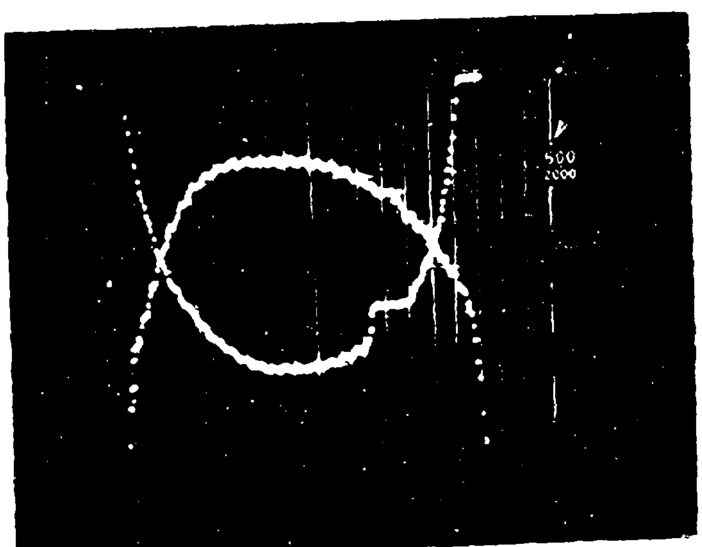

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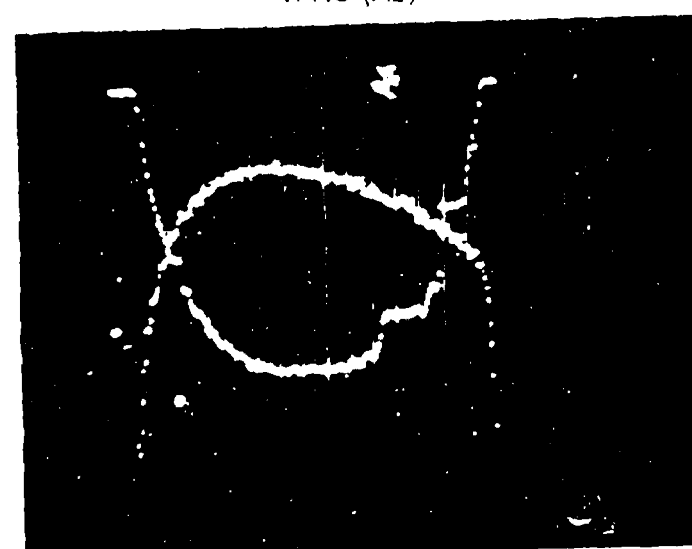

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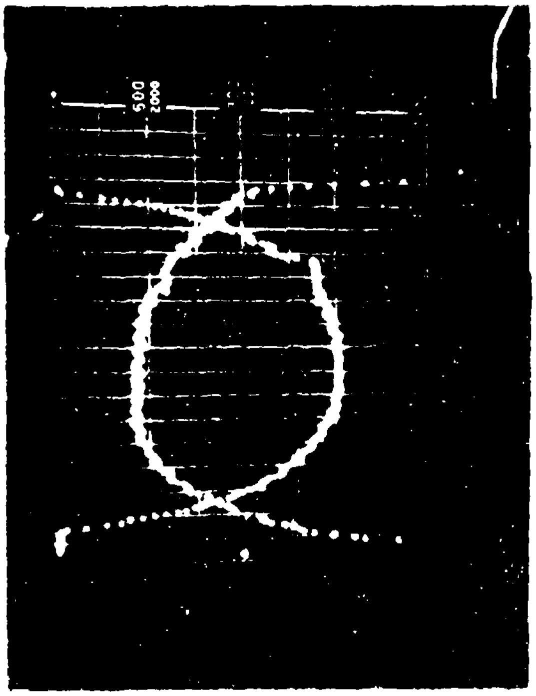

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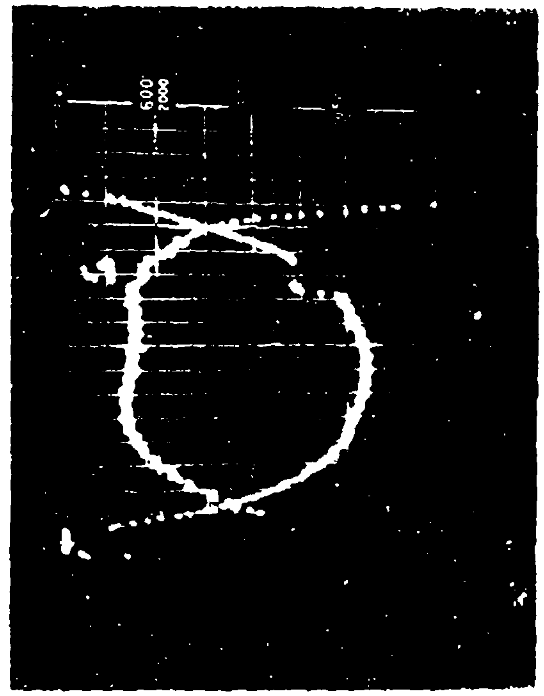

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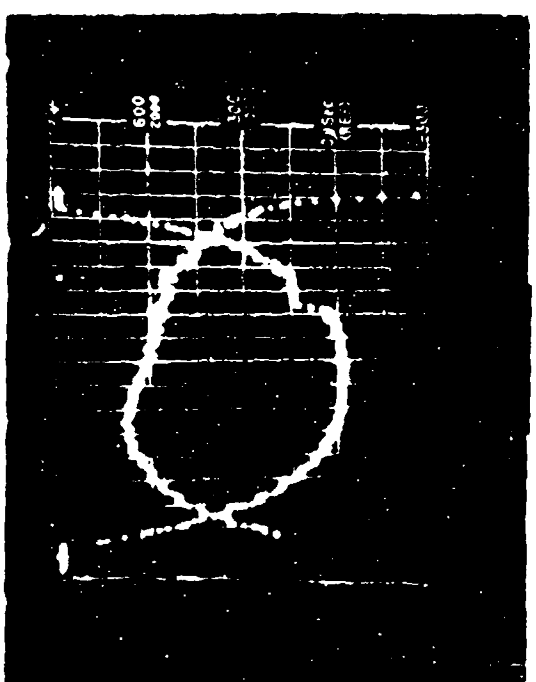

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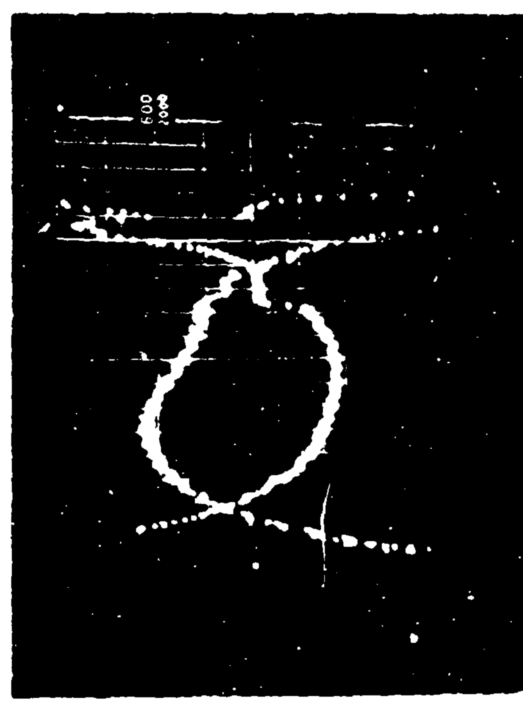

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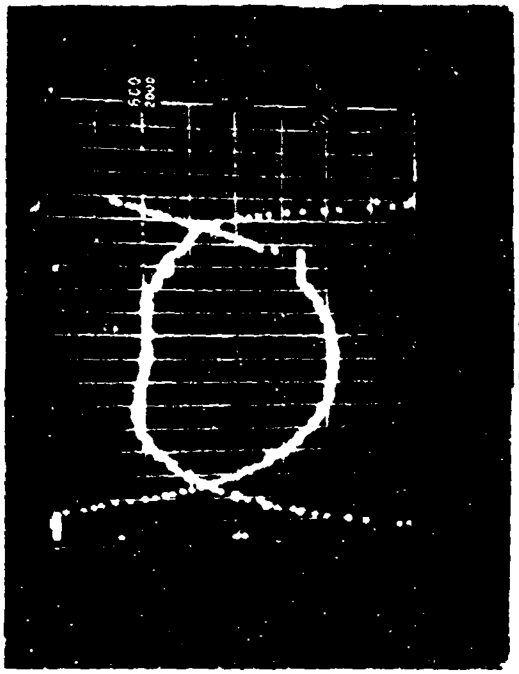
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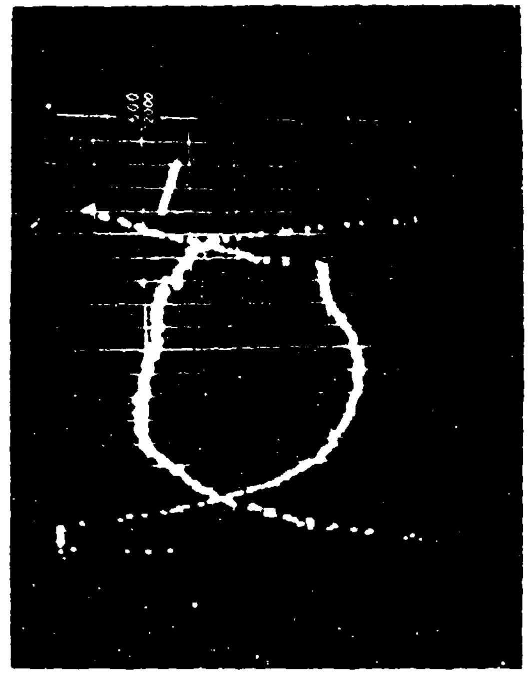
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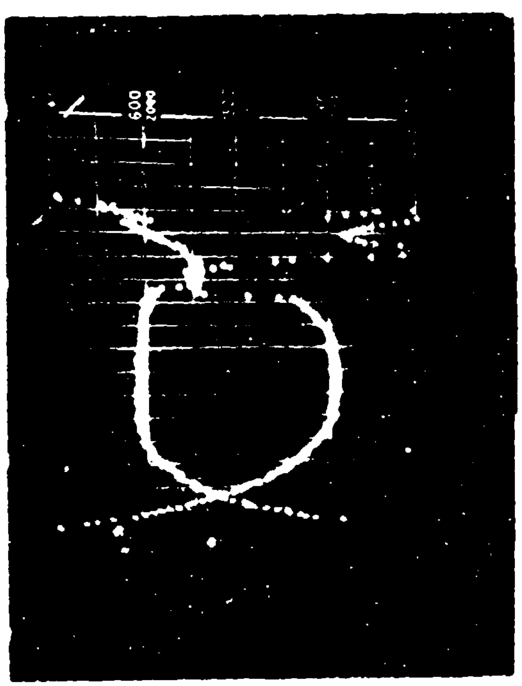
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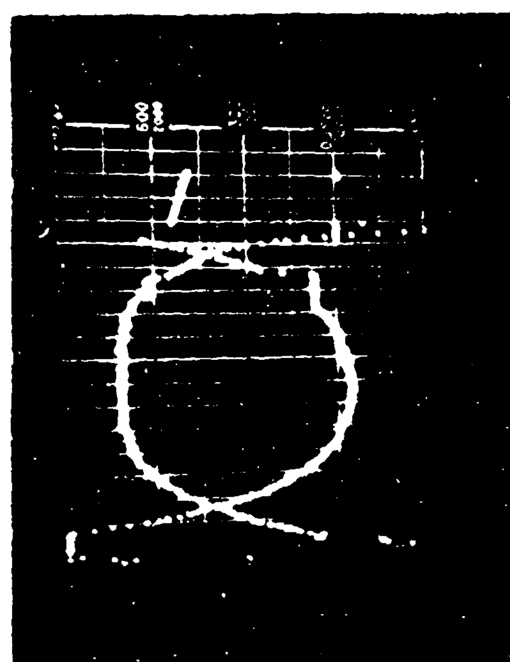
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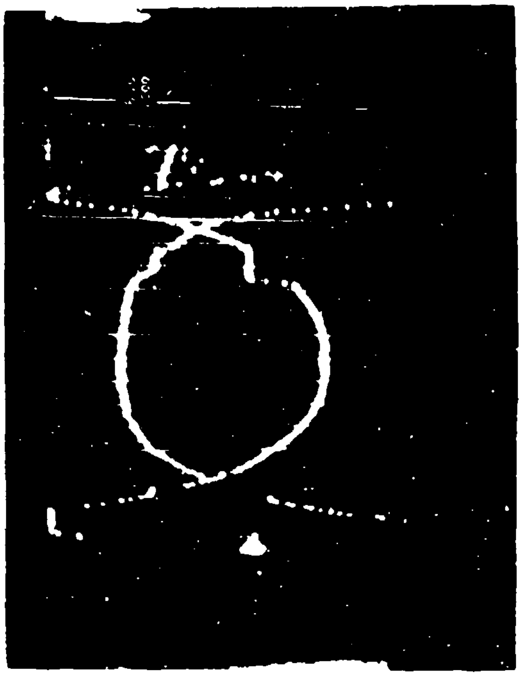

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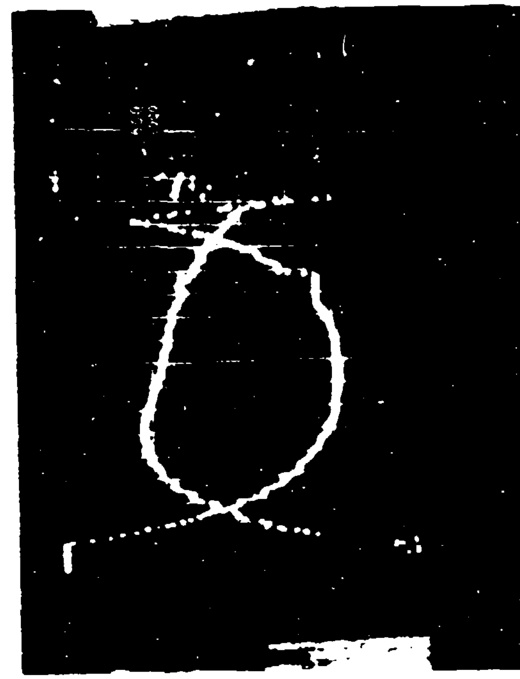

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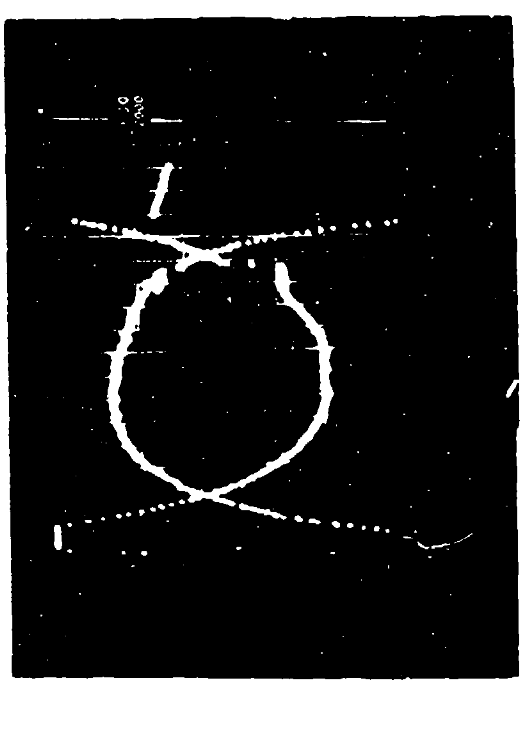

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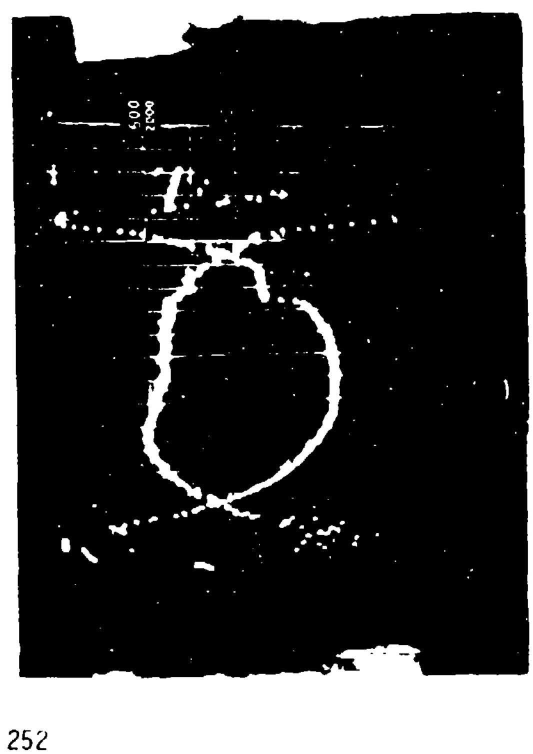

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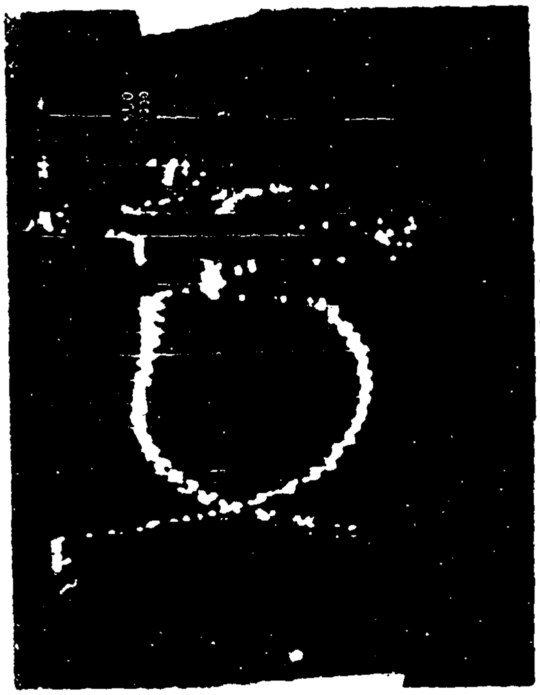

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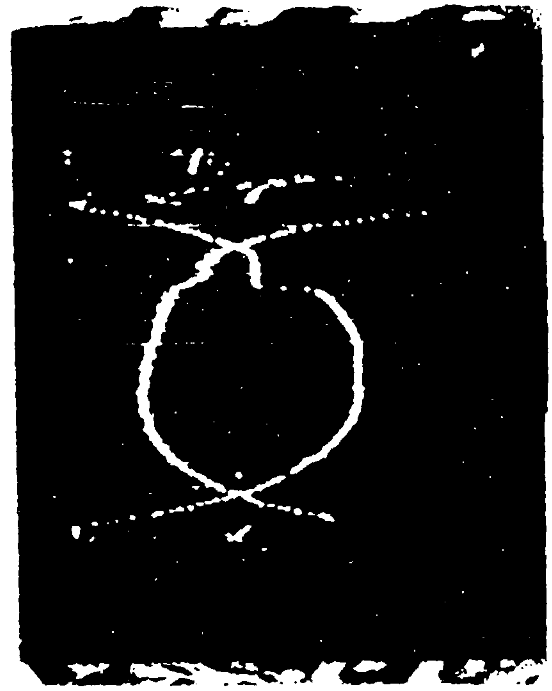

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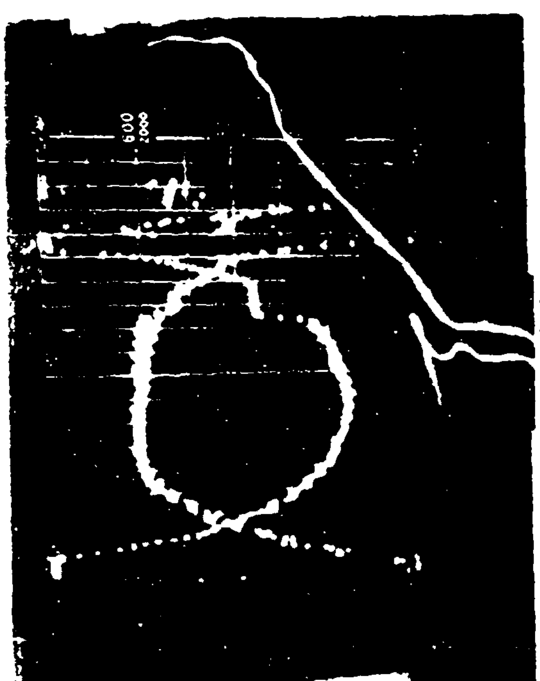

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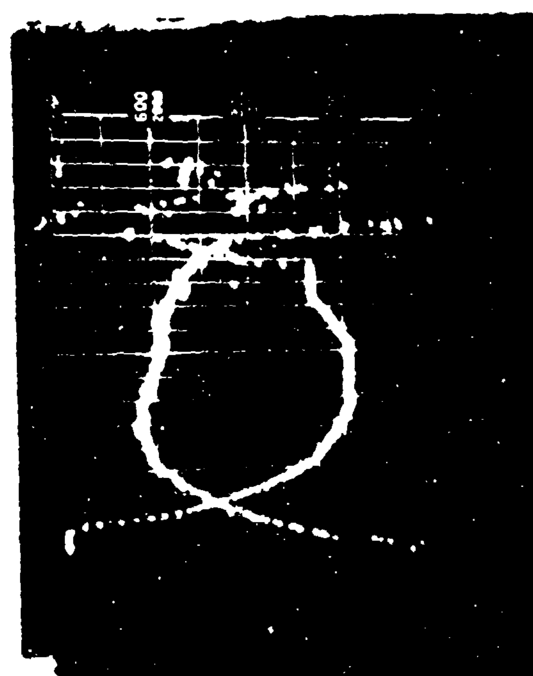

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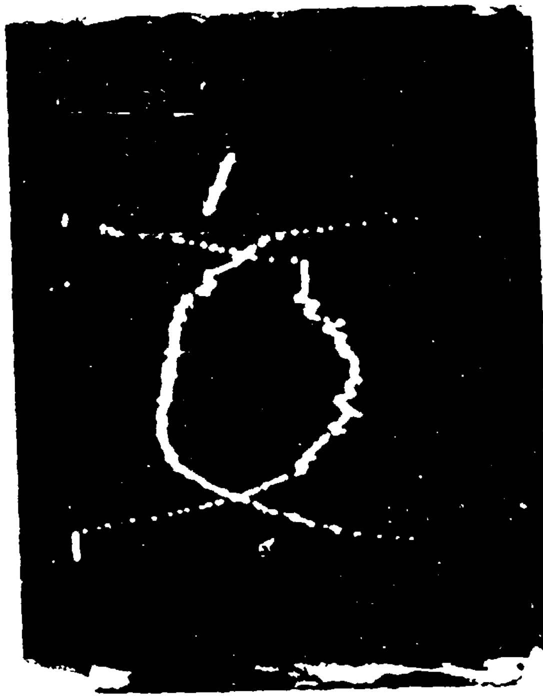

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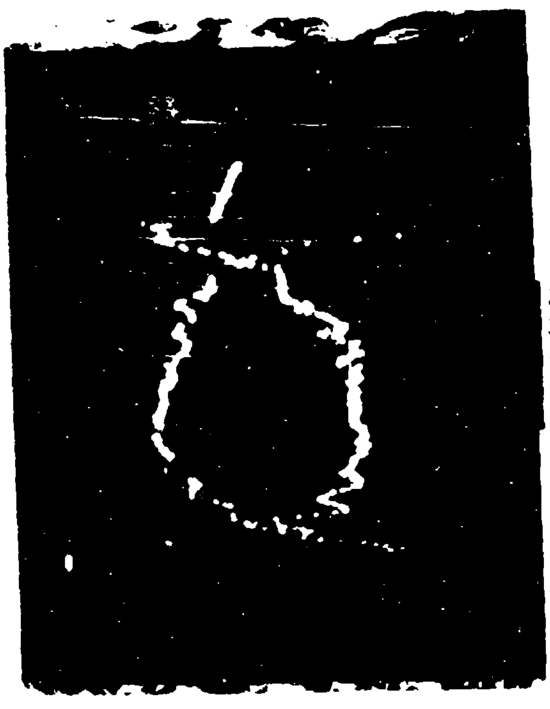

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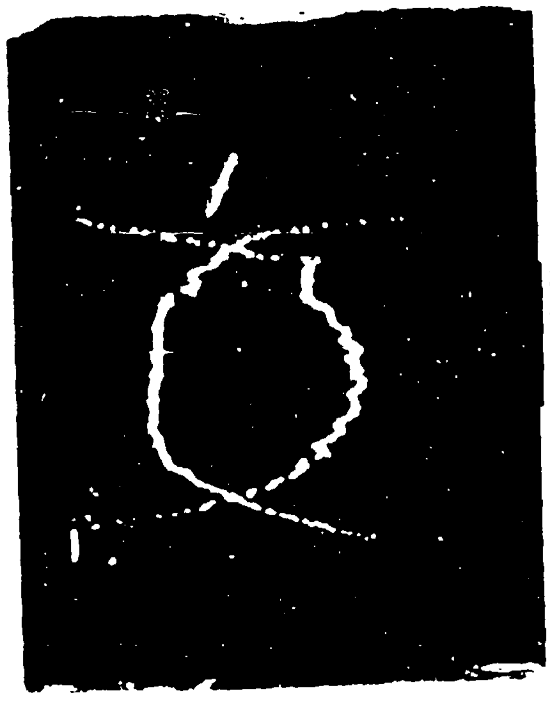

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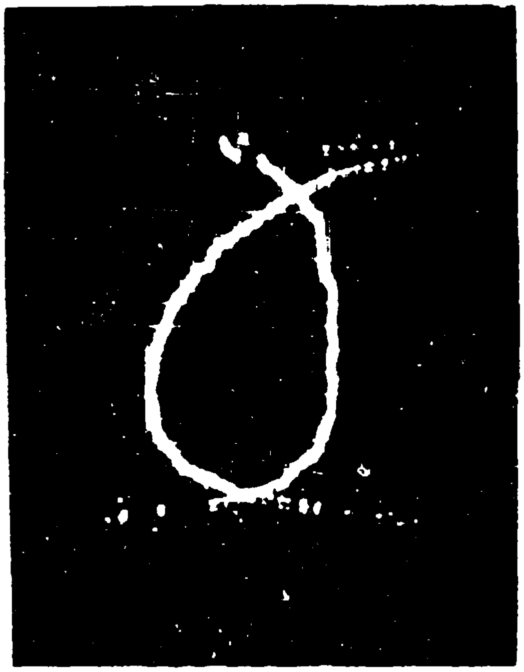

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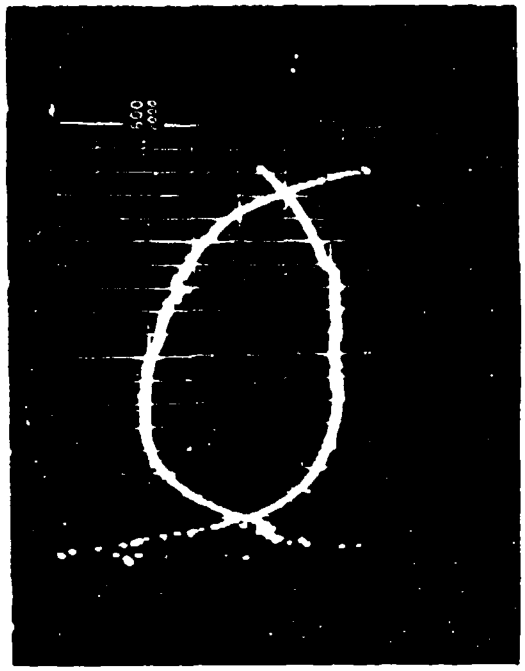

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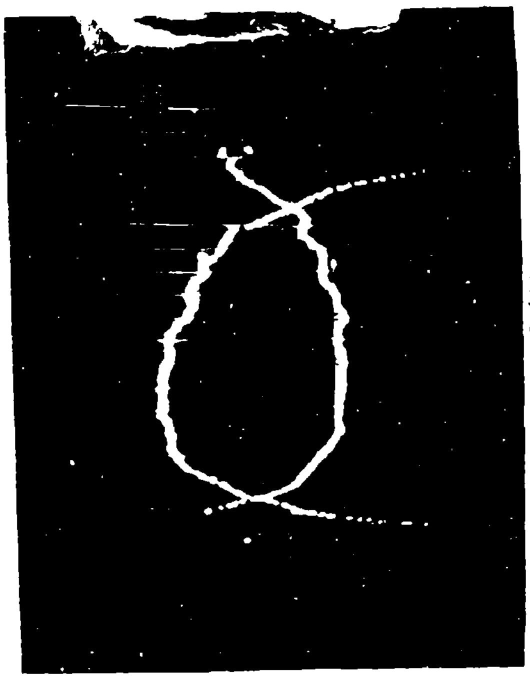

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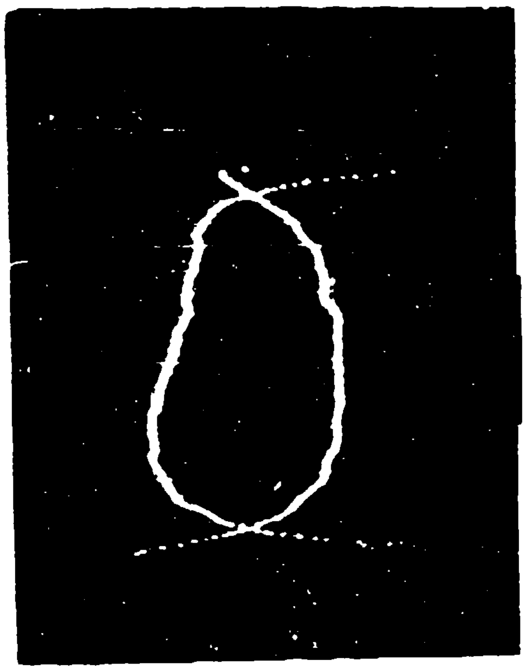

2N20 (A2)

APPENDIX D

16 kb/s VF Modem (AN/GSC38)

CONUS Test Plan

VI. Data Collection

1. McDill AFB - Pentagon

2. Offutt AFB - Pentagon

3. March AFB - NSA Ft. Meade

4. NSA Friendship Annex

16 kb/s VF MODEM (AN/GSC-38) CONUS
FIELD TEST

I. INTRODUCTION

1. Background. Over the past several years there has been considerable effort to design an end-to-end secure voice system with atuomatic key variable distribution for both the civil and military segments of the Federal Government. With the main emphasis of using the CONUS commercial telephone network the civil sector of the government has developed a narrowband (2.4/4.8 kb/s) comcept (ESVN) that has the advantage of easily traversing the available 4 kHz commercial channels and not impacting the normal commercial switching operations. This approach, however, has the potential limitation of simplex operation because of the prevalence of 2 wire transmission facilities, extended call placement time to obtain key variables from key distribution centers (KDC's) (BELLFIELD) that are independent of switches, no call precedence capability, and voice quality and intelligibility that is limited by the A/D technology at the 2.4/4.8 kb/s rate. On the other hand, the DCS secure voice network (AUTOSEVOCOM II) system design has tended toward wideband (16 kb/s) configurations that will provide end-to-end secure voice service using TRI-TAC equipment and integrating into the system a digital switching concept that includes key distribution (TENLEY) as a switching function. The AUTOSEVOCOM II have the advantage of tactical interoperability, call placement precedence, and relatively fast call placement time.

As the design of the ESVN and AUTOSEVOCOM II matured and started toward full scale development there has been congressional concern as to why the government is developing two independent systems that, at least on the surface, appear to be designed to meet the same objective. As a result,

there has been considerable activity in recent months to develop performance and operational requirements, cost information, and technical performance data on the several system design alternatives being considered for both the civil and military secure voice requirements. It is anticipated that by July 1978 there will be a congressional decision as to which secure voice alternatives(s) will go into full scale development. A significant factor affecting this decision is the ability to develop digital channel over AUTOVON and commercial telepnone analog VF facilities. In this respect the two basic alternatives depicted in Figure 1 can be described as follows:

o BELLFIELD - This alternative allows the subscriber to use the AUTOVON network as it is presently configured (except for adding KDC's and perhaps 4 wire analog concentrators). The calling subscriber will place two calls; one to the KDC to acquire a working key variable; and the second to the called subscriber. The VF modem will be located only at the subscriber terminals and the KDCs. The VF modem will have to operate over available 4 or 2 wire VF transmission facilities from subscriber terminal to subscriber terminal. These transmission facilities can be divided into three segments that must be considered. The first is the subscriber loops from the subscriber terminal to the analog concentrator or backbone switch, the second are the concentrator access lines between the concentrator and the backbone switch, and the third are the interswitch trunks (ITS) that may pass through several switches in the AUTOVON network. In this alternative the subscriber's VF access line is a predetermined circuit and its transmission characteristics can be controlled. The other two categories of VF cirucits, however, will be used as available in the AUTOVON network. An option that is also under consideration is similar, but uses the commercial DDD network. The transmission rates & A/D technique for this

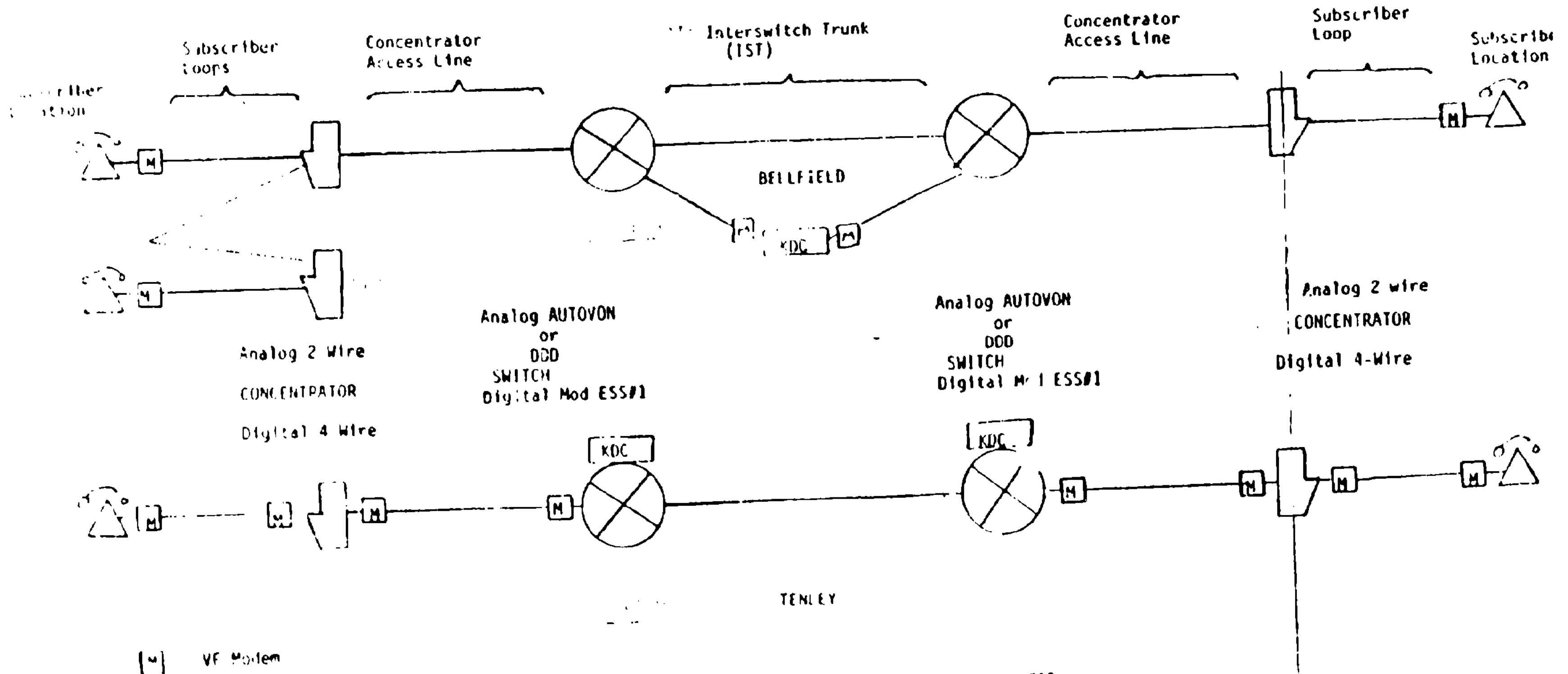

FIGURE 1 TYPICAL SECURE VOICE VF MODEM CONFIGURATION FOR BELLFIELD AND TENLEY ALTERNATIVES

option . could conceivably be 2.4/4.8 kb/s LPC, 9.6 kb/s APC, or 16 kb/s CVSD.

o TENLEY - This alternative is basically the TRI-TAC digital concept using 4 wire digital circuits for subscriber loops, concentrator access lines, and interswitch trunks. The required digital channels are all dedicated. Where it is required to develop a digital channel over an analog facility, pairs of VF modem will be used and dedicated to those circuits. The modem used in this manner can be adjusted to particular circuit parameters and will not experience the buildup of analog circuit impairments associated with multiple links. The transmission rates and A/D technique for this concept could be 2.4/4.8 LPC, 9.6 kb/s APC or 16 kb/s CVSD.

Clearly, the performance of state-of-the-art modems operating at 2.4 kb/s, 4.8 kb/s, 9.6 kb/s and 16 kb/s in the system configuration described above will heavily influence the system alternative(s) selected for development. To obtain these performance results the test program was determined to be essential and the Air Force was tasked to undertake such a program in cooperation with the Narrowband Secure Voice Consortium. The Narrowband Secure Voice Consortium has guided the RDT&E of various LPC, APC and CVSD A/D technique that are being considered for these system applications. The experience and information gained by this activity will contribute significantly to the current test program.

In response to the above mentioned tasking, the Air Force (contracted with Harris) prepared a preliminary test plan. An ad hoc working group was established to finalize the test plan, guide the taking of data and prepare the final report. The working group consists of the following representatives:

AD HOC WORKING GROUP

DCEC	Mr. Joe Mensch (Chairman)	703-437-2316
*RADC	Capt. Joe Laposa (Test Director)	315-330-4374
*DCEC	Mr. Warren Woolsey	703-437-2316
*NSA and Narrowband Consortium	Mr. Tom Termain	301-796-6272
NSA	Mr. Mitchell Brown	301-796-6272
*AT&T	Mr. David Lee	202-457-4736
AT&T	Mr. Bill Egan	202-457-4187
DCA-ASII	Mr. Bob Havrilla	202-692-0607
DCEC	Mr. Jerry Helm	703-437-2441
ESD	Capt. Keith Brown	617-478-4509
DCEC	Mr. Ed Schonborn	703-437-2244
DCEC	Mr. Matt Prisutti	703-437-2416
AFSC	Mr. Robert Kenyon	
HQ USAF	Maj. Lloyd Davis	Von-225-9640
HQ USAF	Maj. David Jetter	Von-225-5247
DCEC	Mr. Reuban Krutz	703-437-2251

*Point of contact and responsible for organization coordination.

The preliminary test plan called for site survey tests at eight potentially good locations, more extensive field test at four of the surveyed sites and simulation tests at Ft. Meade. The site survey tests have been completed and this document is the test plan for the field tests and simulation tests.

Since it is anticipated that by mid-1978 there will be a congressional decision on the preferred approach, it is essential that the test results be available before the end of May 1978. The available time to conduct the test program is extremely short, therefore, it must be emphasized that the necessity of selecting among the various alternatives is essential, and every effort should be made to take data that is representative of the intended application and is sufficient to support the final conclusion. It is essential, therefore, that each agency and MILDEP involved participate closely with the planning and execution of the tests and jointly prepare a statement of conclusions and recommendations resulting from the test program.

2. Objective. The objective of the CONUS VF Modem Test Program is to assemble sufficient data on the performance of state-of-the-art VF modems when operating over typical CONUS AUTOVON and DDD VF circuits. The modems that will be tested are the AN/GSC-38 16/8 kb/s VF Modem developed by Harris Corporation for the Air Force and the CODEX 9600 commercially available VF modem, which operates at 9.6, 7.2 and 4.8 kb/s.

Figure 1 shows typical multiswitch secure voice configuration and the circuits the call must traverse for both the TENLEY and BELLFIELD alternatives. The goal of the Test Program is to provide sufficient data such that the end-to-end performance for each alternative can be estimated. To achieve this goal data must be taken to characterize subscriber loops, and concentrator access lines for the AUTOVON network. Since the use of the commercial DDD network is limited to the BELLFIELD approach only end-to-end performance measures are required. The type of performance measurements that will be made are BER, channel characterizations and voice recording. Once these channels are characterized it is necessary to interpert how the data applies to the total system before any conclusions can be drawn. AT&T has indicated that they have available documentation quantifying the distribution of the various types of channels that will be measured. The combination of the measured data and distribution information should allow the test committee to make reasonable conclusions and recommendations.

. Approach - Since the avaliable time would allow approximately one month of testing, only a relative few locations could be tested. Further, simulation tests have been planned to provide data taken under more controlled conditions The rationale for site selection is discussed in Section III. The test will be conducted between the following three field sites and two hub sites.

WEEK	FIELD SITE	HUB SITE
1	McDill AFB Fla	Pentagon Arl. VA
2	Offutt AFB NE	Pentagon Arl. VA
3	March AFB CA	NSA Ft. Meade MD
4	Simulation Tests	NSA Friendship Annex

The field and hub sites are at AUTOVON concentrator locations. From these locations test data will be collected to characterize the following categories of circuits.

- o AUTOVON TESTS
  1. Concentrator Access Line
  2. Tandem Switching
  3. Subscriber Loops
- o COMMERCIAL TELEPHONE DDD

The test conducted over the concentrator access lines will be one-way tests from concentrator to concentrator as shown in Figure 1. The concentrator access line test results will therefore include 2 concentrator access lines and one interswitch trunk. The tandem switch tests will then extend those results to include up to five interswitch trunks. The number of interswitch trunks will be controlled by using a switch "dial-through" technique. Ten AUTOVON switches have been provided telephone numbers which when called gives the calling party a second dial tone

such that the next switch or hub test site number can be dialed. This capability has been provided by AT&T and allows the test team at the field sites to provide some control of the interswitch circuits to the hub site. The limitations in controlling these IST's is discussed in Section V5. Subscriber loop tests will also be run from each field site. At each field and hub site the modems will be moved to potential subscriber locations to provide typical end-to-end performance results. Subscriber loops and concentrator access lines will also be tested by looping back circuits to the test site locations. The DDD tests will be one-way simplex tests from each of the subscriber locations at the field sites to the subscriber locations at the hub site and vise versa.

For each of these four test configurations the following data will be taken:

- BER: First the circuit will be tested at 16 kb/s and if the error rate is $\leq 10^{-3}$ no further test will be conducted on that circuit. If the BER $>10^{-3}$, the circuit will be tested at 8.0 kb/s and 9.6 kb/s. If the resulting error rate is $\leq 10^{-3}$, no further BER test will be made. If the error rate $> 10^{-3}$, the BER will be measured at 4.8 kb/s.

Channel Characterization - If the BER at 16 kb/s is $\geq 10^{-2}$, the channel impairments will also be measured. And further on approximately every tenth call that is tested the channel impairments will be measured regardless of error rate. These measurements are defined in Section V2.

Voice Recordings - Voice recording will be made at 16 kb/s using CVSD to be able to subjectively demonstrate the effect of channel errors on system end-to-end performance. The recordings will be made on circuits with error rates that have BER's in the questionable range of acceptable performance, i.e., $>10^{-2}$.

Further, the performance of the modem will be evaluated over the NSA channel simulator using a variety of combinations of channel impairment parameters. These channel impairment parameters are defined in Section V3.

II. Schedule and Manpower

1. Schedule. Figure 1A shows the program schedule. Approximately one week of testing will be done at each test site and a briefing will be given at DCEC the week of May 5th to coordinate the finding and conclusions. Then, results will be presented to HQ DCA and C^3I the week of May 12th. A draft final report will be available for coordination by 5 June and the Final Report will be distributed by the end of June.

2. Manpower. The test team will consist of the following personnel at the various field test sites. Each organization is responsibile for providing security clearance and travel to the test sites.

(1) Pentagon - April 3 to April 14

RADC - Sal Nasci (Team Leader)

Harris - Fred Kilmeyer

DCA - Matt Prisutti, April 3, April 7, April 10-14

NSA - Doug Rohikka

AT&T

(2) McDill AFB Fla - April 3 to 7

RADC - Mr. Joe Laposa, (Team Leader)

Harris - Mr. Jeff Myers

DCEC - Mr. Ben Krutz

AT&T - Mr. Bill Egan

NSA - Mr. Mitchell Brown

(3) Offutt AFB Nebr. April 10 to April 14

RADC - Captain Don Talada (Team Leader)

Harris - Mr. Frank Perkins

DCEC - Mr. Ben Krutz

AT&T - Mr. Bill Egan

NSA - Mr. Doug Rohikka

(4) March AFB California   April 17 to April 21

RADC - Mr. Don Talada (Team Leader)

Harris - Mr. Frank Perkins

DCEC - Mr. Ben Krutz

AT&T - Mr. Bill Egan

NSA - Mr. Doug Rahikka

(5) Ft. Meade NSA   April 17 to April 21

RADC - Sal Nasci (Team Leader)

NSA - Mitchell Brown

Harris - Fred Kilmeyer

DCA

AT&T

(6) Friendship Annex NSA   April 25 to 27

RADC - Joe Laposa (Team Leader)

DCA - Ben Krutz

NSA - Mitchell Brown, Tom Tremain

Harris - Frank Perkins, Dan McRae

While at the test site, the test team members are responsible to the test team leader who in turn is responsible to the Test Director. The test team leader is responsible for the execution of the test plan at his assigned site and will assign each test team member as appropriate to accomplish the objectives of the test plan.

PAGE __ OF __

DEFENSE COMMUNICATIONS AGENCY MILESTONE CHART

SCHEDULE NO. ____

TITLE	CLASSIFICATION	AS OF DATE
FIGURE 1A. AN/GSC-38 16 KB/S VF MODEM CONUS TEST PLAN	Unclassified	20 March 1978

ITEM NO.	MAJOR MILESTONES	March 24	31	April 7	14	21	28	May 5	12	19	26	June 2	9
1.	Tasking to AF (16 Feb)												
2.	Preliminary Test Plan (1 Mar)												
3.	Preliminary Test Plan Coord. (13 Mar)												
4.	Site Survey												
5.	Final Test Plan												
6.	Field Tests												
	a. McDill to Pentagon												
	b. Offutt to Pentagon												
	c. March to Ft. Meade												
7.	Simulation Tests Ft. Meade												
8.	Preliminary Briefing DCEC 8 May												
	C^3I DCA 15 May												
9.	Final Report Draft 5 June												
	Final 30 June												

III. Site Selection - The selection of the Field test sites was based on three considerations: Location of AUTOSEVOCOM II subscribers, availability of various combination of transmission media; and results of site surveys. Further an important consideration due to the short time available to plan and schedule this test program was the ability to gain access to the test sites. This last reason nearly dictated that all test sites were located at Air Force facilities.

1. AUTOSEVOCOM II Subscriber locations: Figure 2 shows the anticipated location of all AUTOSEVOCOM II subscribers in CONUS. They are plotted as single subscribers since they will be remote from the concentrator and will have long subscribe loops. The groupings of 2-30, 31-60 and 61-90 represent locations of the small, medium and large sized concentrators. For grouping of over more than 90 subscribers, there would be multiple concentrators used. The following table lists these locations with more than 90 subscribers.

LOCATION	# SUBSCRIBERS
Pentagon	431
Ft. McPherson	332
Ft. Bragg	328
Washington	266
Arlington	237
Offutt	222
Ft. Hood	190
Dayton	160
Ft. Meade	124
Kelly AFB	120
	2410

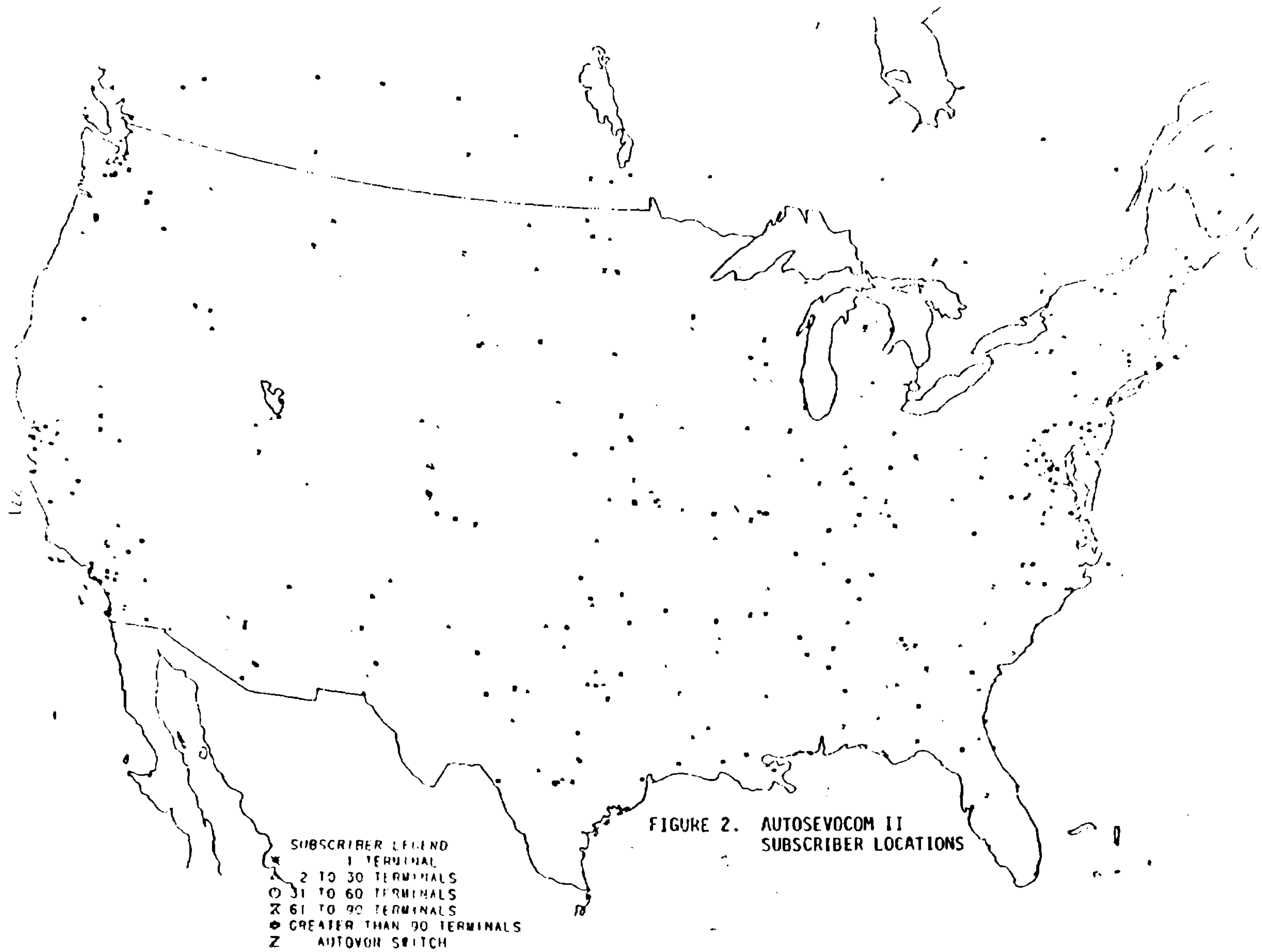

FIGURE 2. AUTOSEVOCOM II SUBSCRIBER LOCATIONS

The above list represents approximately one third of the total AUTOSEVOCOM II subscribers in CONUS. With this information in mind and the desirability of selecting Air Force facilities, the following eight sites were selected for the survey phase of the test program.

SURVEY SITE LOCATION	# SUBSCRIBERS
Pentagon	431
Offutt	222
Ft. Meade	124
March AFB	65
Cheyenne Mt.	56
McCord AFB	49
Vandenberg	44
McDill	24
	1015

2. Transmission Characteristics: AT&T did a preliminary transmission characteristics survey for the eight sites selected.

The results are reflected in Table I. The transmission media for each of the sites is shown in Figure 3 through 10. After reviewing this data and taking into consideration the accessibility of the facilities the following locations were selected:

- o Pentagon
  - o represents a large concentration of potential subscribers which exercise large quantify of call.
  - o The media (cable) used the concentrator access lines should be sufficiently transparent to isolate the performance of the access loops at the field sites.

- Offutt AFB
  - represents a large number of potential subscribers.
  - media (L carriers) used for concentrator access line sufficiently transparent to isolate the effect of multiple IST.
- McDill AFB
  - variety of access area media
  - accessible
  - close to home base of team and therefore good location to start test program.
- March AFB
  - excellent variety of Access area media

3. Site Survey Results Summary:

	VANDENBERG	MARCH	MCCORD	MCGILL	OFFUTT	ARMY-FT.MEADE	NSA	PENTAGON	CHEYANNE MT.
End Link Makeup									
Comb VF Cust Cable		✓				✓			
Telco		✓	✓	✓	✓	✓	✓	✓	
Local digital/analog	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓ ✓	✓ ✓		✓ ✓
Tander Cable	✓	✓	✓			✓	✓		
VF Cable									
22H88	✓	✓						✓	
Mixed H88									
HL Pairs								✓	
Customer Cable						✓			
Customer Cable (Questionable Qual)		✓							
T Carrier									
D1					✓	✓			
D2						✓			
D3						✓			
Comb D1D-D3						✓	✓		
Lenkert "T"									
Other T									
N & ON Carrier									
N1			✓				✓		
N2							✓		
N2									
ON1			✓						
ON2									
Lenkert/Collins									
Broadband LMX	✓	✓	✓	✓	✓	✓	✓	✓	✓
TD2			✓						
TD3									
TH									
TN									
Collins				✓					
Coax									
L1					✓				
L3									
L4									
L5									

TABLE I. SUMMARY OF TRANSMISSION LINK AND FACILITIES AT TEST SURVEY SITES.

CKT # | TERMINALS | C.O. # D | SERVICE DATE

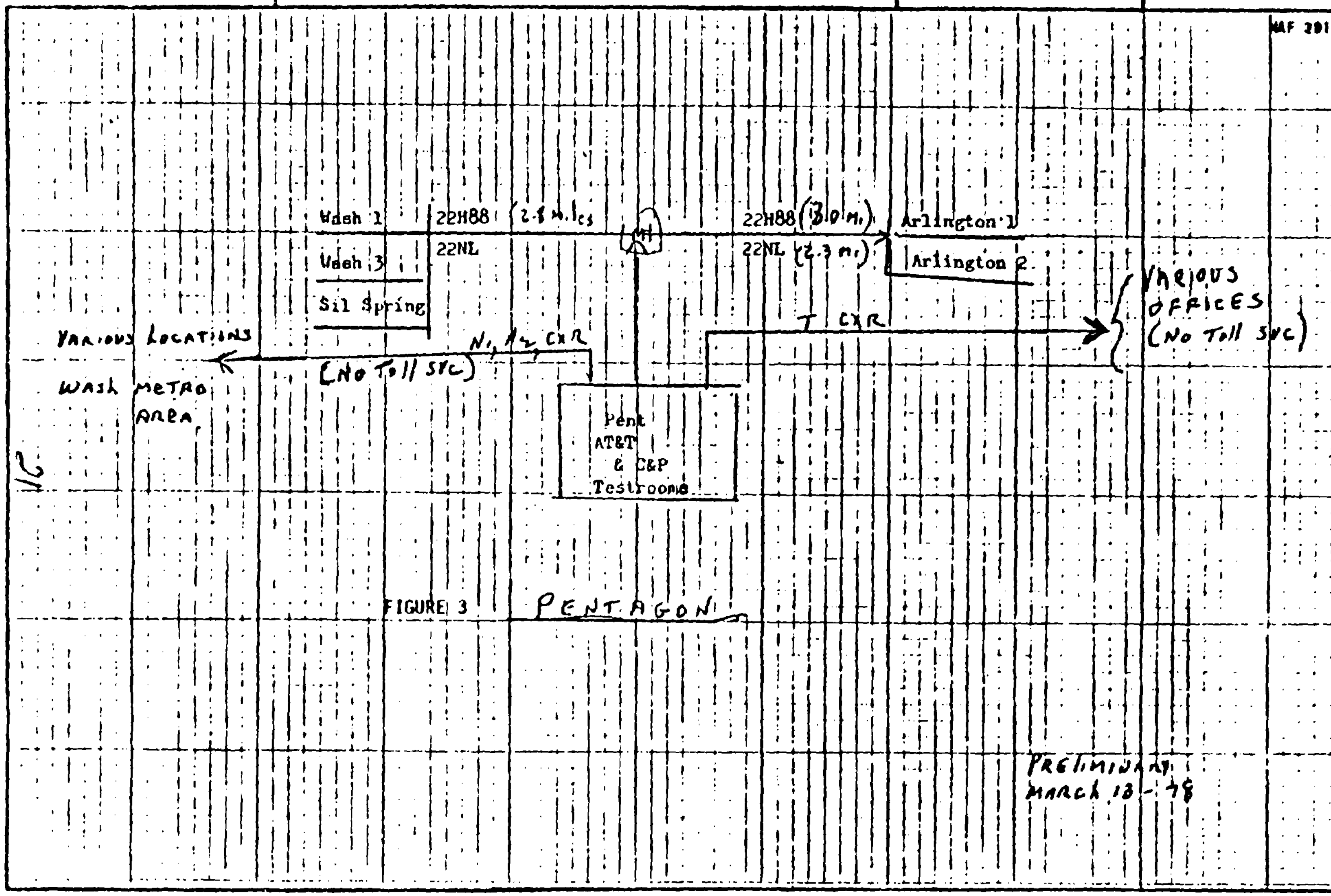

FIGURE 3

Reroute Code ______ Select Ckt Code ______ Select Net Code ______ Class of Service ______ Group Class ______ Operation ______ Design'd Class'n ______

LEI D | TERMINALS | C.O. D | SERVICE DATE

D

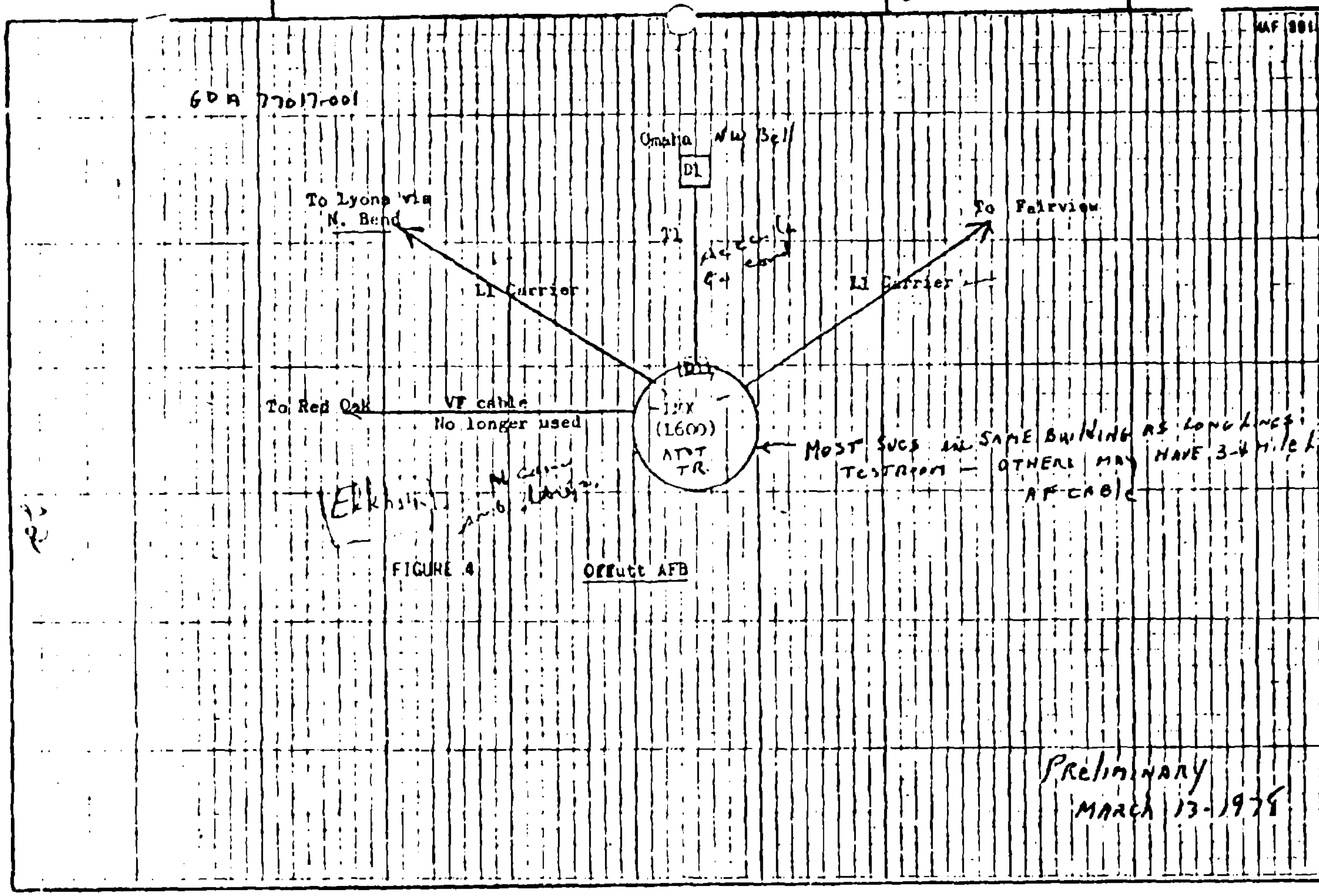

FIGURE 4

Reroute Code ______ Select Ckt Code ______ Select Net Code ______ Class of Service ______ Group Class ______ Operation ______ Design'd Class'n ______

Spec Feat (Class Mark) ______ Control ______ Contact Office ______ EML ______ VNL ______ N Factor ______

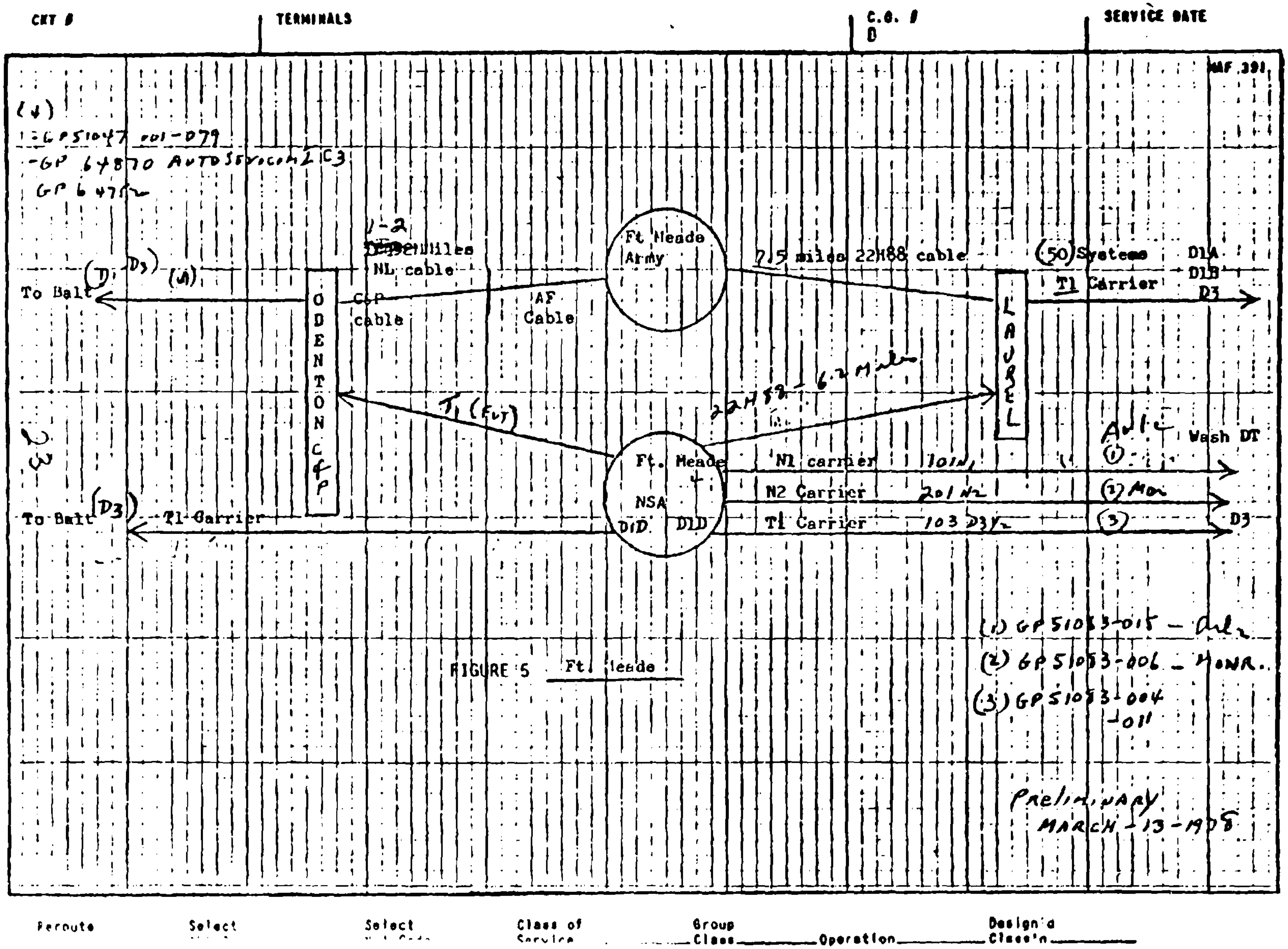

FIGURE 5 Ft. Meade

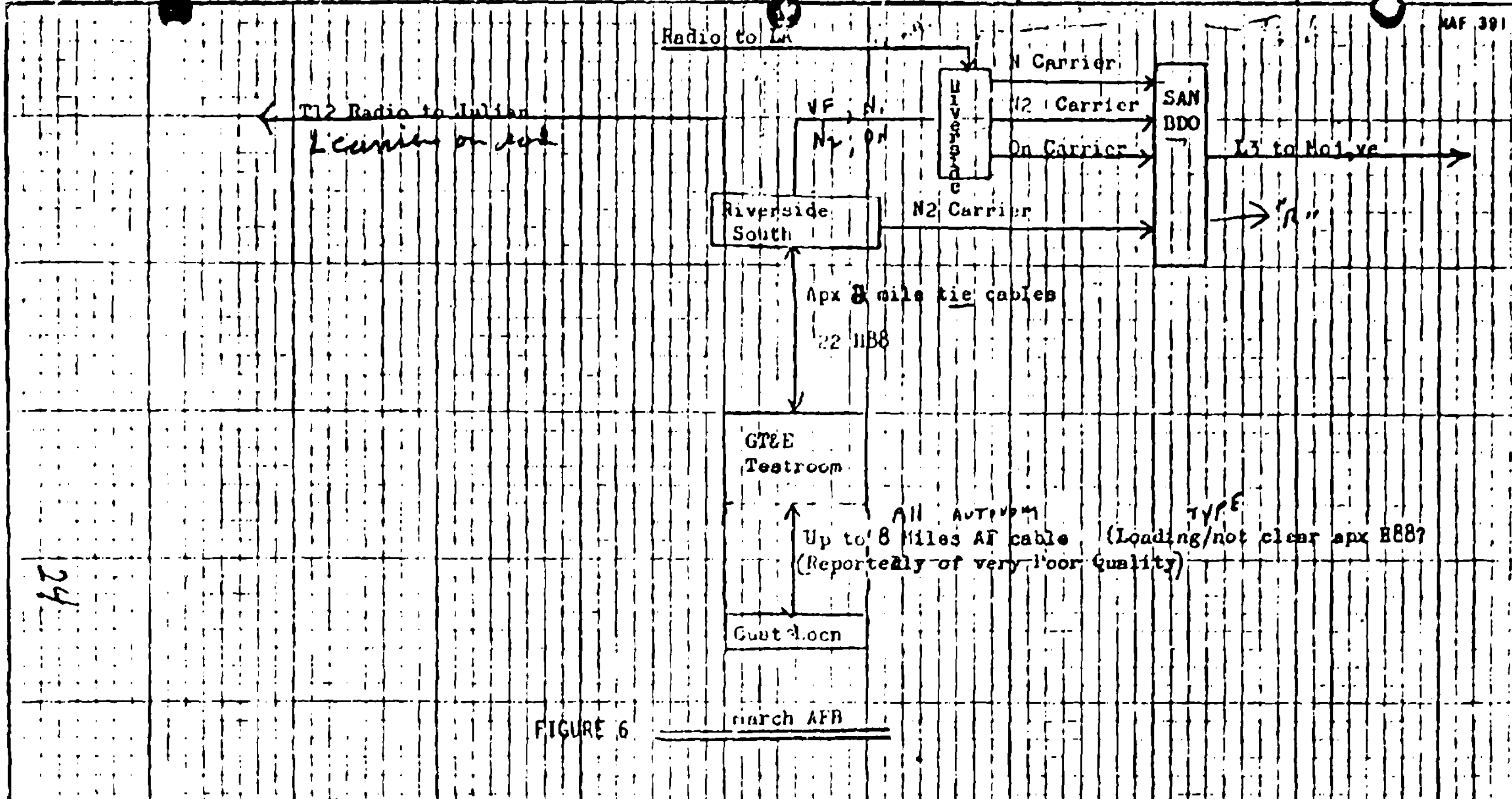

FIGURE 6

PRELIMINARY
MARCH 13-1978

24

Reroute Code ______ Select Ckt Code ______ Select Net Code ______ Class of Service ______ Group Class ______ Operation ______ Design'd Class'n ______

Spec Feat (Class Mark) ______ Sub Control ______ Contact Office ______ EML ______ VNL ______ B Factor ______

CKT # | TERMINALS | C.O. # D | SERVICE DATE

MAF 381

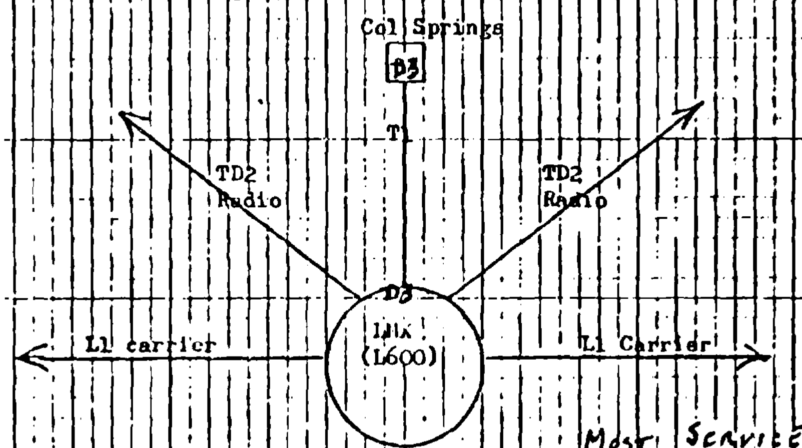

FIGURE 7 Cheyenne Mtn. ESS Machine Testroom on base

MOST SERVICES IN SAME LOCATION AS LL. TESTROOM – (LLX IN BUILDING)

PRELIMINARY
MARCH 13 1978

Reroute Code ____ Select Ckt Code ____ Select Net Code ____ Class of Service ____ Group Class ____ Operation ____ Design'd Class'n ____

Spec Feat (Class Mark) ____ SCS Control ____ Contact Office ____ EML ____ VNL ____ Q Factor ____

CKT # | TERMINALS | D

MF 391

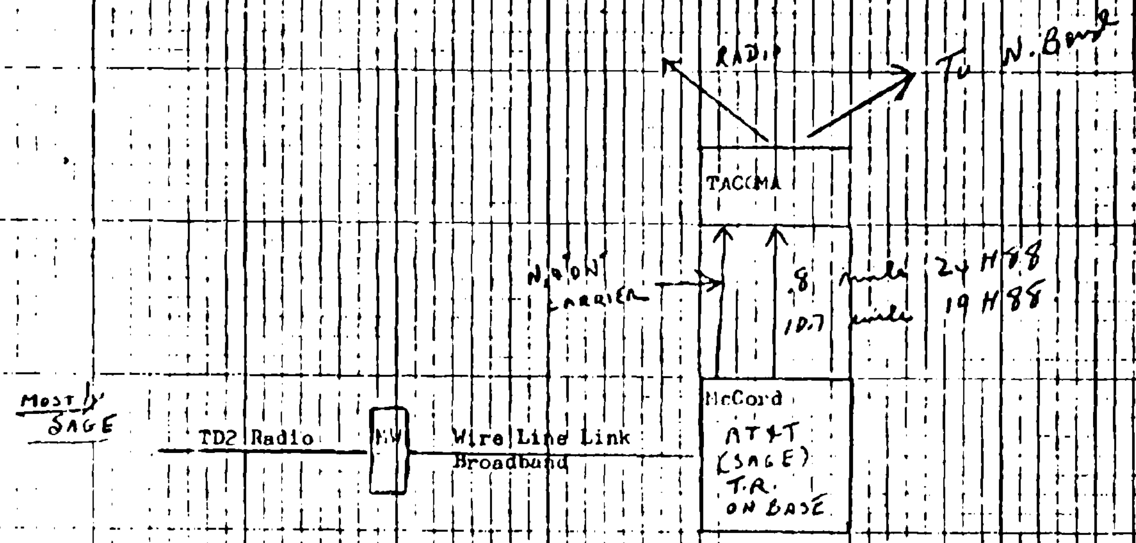

FIGURE B McCORD

Prelim
March 13-1978

Reroute Code ______ Select Ckt Code ______ Select Net Code ______ Class of Service ______ Group Class ______ Operation ______ Design'd Class'n ______

Spec Feat (Class Mark) ______ Control ______ Contact Office ______ EML ______ VNL ______ B Factor ______

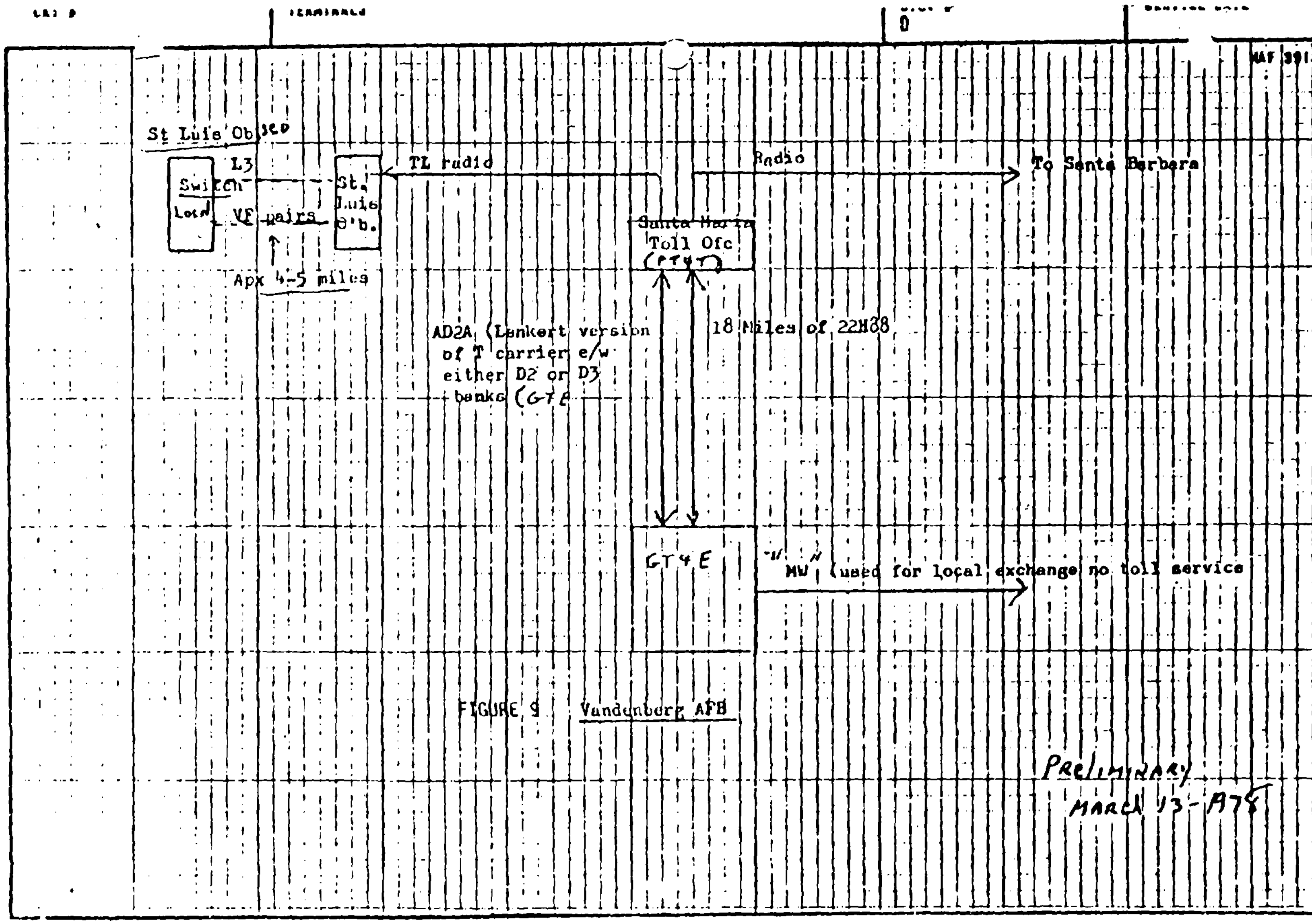

FIGURE 9 Vandenberg AFB

Reroute Code ______ Select Ckt Code ______ Select Net Code ______ Class of Service ______ Group Class ______ Operation ______ Design'd Class'n ______

Spec Feat (Class Mark) ______ Sub Control ______ Contact Office ______ EML ______ VNL ______ B Factor ______

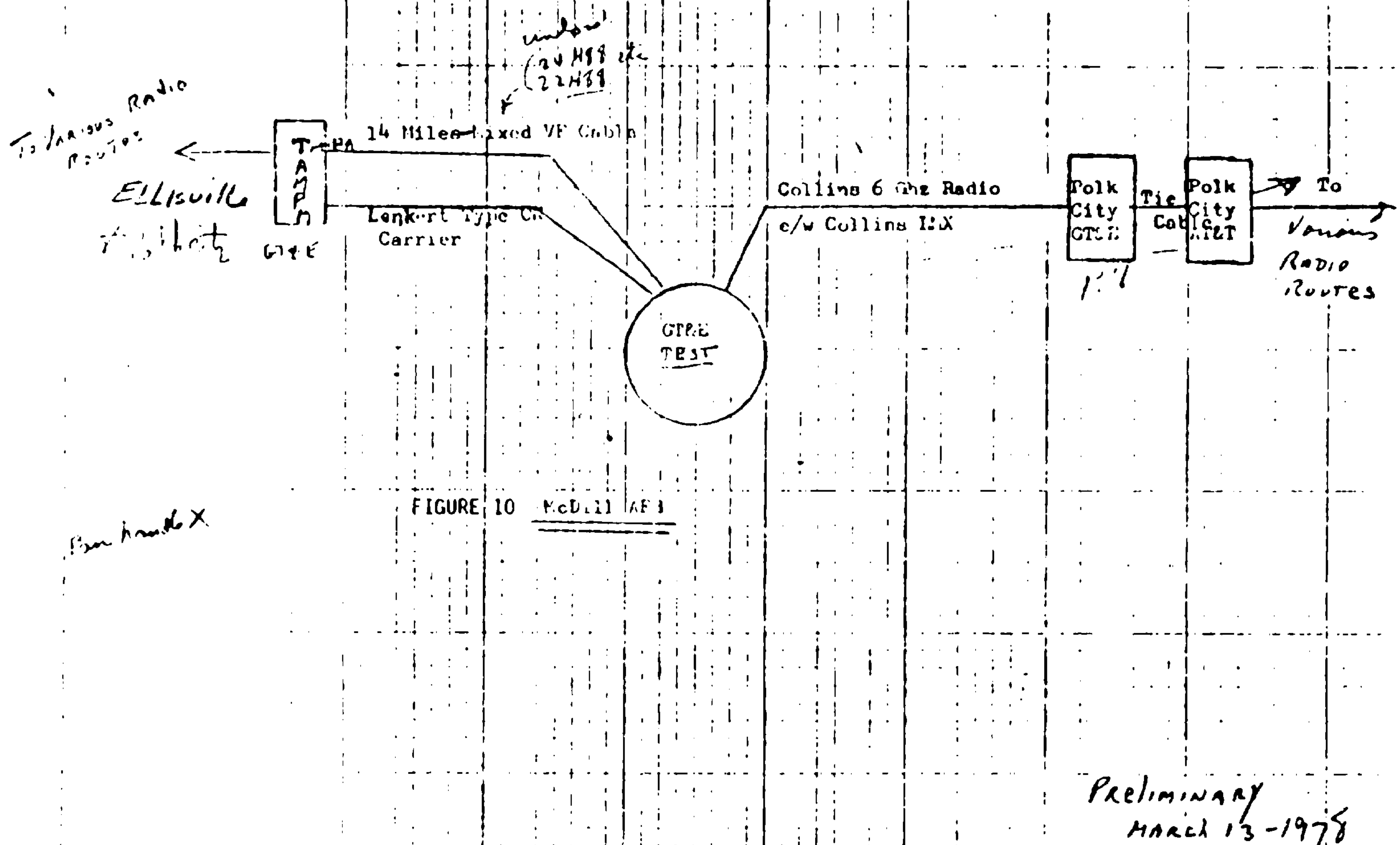

FIGURE 10 McDill AFB

Reroute Code______ Select ... Code______ Select Net Code______ Class of Service______ Group Class______ Operation______ Design'd Class'n______

IV. Test Procedure - The following paragraph discusses several areas of consideration that are not only good test program practice but are additionally important where the test program and procedure may be subjected to scrutiny and contention.

1. Equipment Performance Validation - The performance of all equipment to be tested and associated test equipment will be evaluated before the test program and again after the field test to validate their performance while the data was taken. Further all test equipment will be calibrated before the field tests. Specifically the following test will be made on the VF modems, CVSD terminal, magnetic tape recorder and the Halcyon 520B.

a. VF Modems - The following VF modems will be used to obtain the data required by this test program.

Modem Type	Operation Rate Kb/s
o AN/GSC-38 16 Kb/s VF Modem	16 8
o CODEX 9600	9.6 4.8

Each modem will be adjusted and/or repaired such that parameter values and performance levels are within the specified value for the indicated rates of operation. When each of these modems are judged to be in normal operating condition the following set of validation test data will be taken at each of the specified rates such that the BER goes from 10^{-6} to 10^{-1}.

(1) BER versus noise level. dBrno

(2) BER versus phase jitter (degrees peak-to-peak at 20 Hz, 50 Hz, 60 Hz, 120 Hz, and 300 Hz).

(3) BER versus Frequency Off-set (0 to ±20 Hz).

(4) BER versus phase hits - degrees peak (405 hits/15 min.) (hit 4 m sec wide).

(5) BER Versus harmonic distortion. (2nd alone, 3 alone, and 2nd and 3rd equal level) (up to 15%)

(6) BER versus impulse hits (405 hits/15 min.) (hits 4 m sec long)

The amplitude and phase delay characteristics used during these tests will be equivalent to a C2 conditioned line. Once the modem have been adjusted a test as specified above no additional adjustments or modifications that will change the performance indicated by the validation test data shall be made. The modems are briefly described as follows:

o Codex 9600 Modem - The codex 9600 can transmit at data rates of 4800, 7200, and 9600 bps. At all three data rates, the 1706 Hz carrier is modulated at a rate of 2400 baud. At 4800 bps, the complex amplitude modulation is 4 phase, 1 amplitude; at 7200 bps, the modulation is 4 phase, 2 amplitude; and at 9600 bps the modulation is 4 phase, 4 amplitude. Between each adjacent amplitude level, there is an additional phase shift of 45°. In addition, the possible amplitude levels are not linearly spaced but are biased toward the higher levels. The complex amplitudes have been spaced to optimize the performance of this modem under high noise and high phase jitter environments. The Codex 9600 uses a 31-tap digital equalizer that is automatically and continually updated by the modem.

o AN/GSC 38

The Harris 16 Kbps modem is a high speed, adaptively equalized modem capable of operating over 3 KHz voice frequency telephone circuits at 16 Kbps per second. The modulation technique employed is Quadrature Amplitude Modulation (QAM) with four amplitude rings of 16 phases each. No carrier or pilots are required. The modem incorporates an adaptive equalizer which allows the modem to compensate for the amplitude and envelope delay characteristics of the circuit. The synchronization/ equalization process is initially activated by a nine (9) second training sequence. In normal operation the modem is fully automatic and does not require manual intervention.

For fault isolation, several manually selectable modes are available including digital and analog loopback features. The modem can also operate at 8 kbps when required.

b. CVSD terminals - Recording tapes will be prepared during the course of the field test program to subjectively demonstrate the effect of channel errors on system end-to-end voice quality. The CVSD A/D devices that will be used are the Codex Speech Digitizer suitcase units operating at 16 kb/s CVSD. Each CVSD unit will be adjusted/and or repaired such that its parameter values and performance levels are with the specified value. The CVSD units will be provided by DCEC and have recently been refurbished by Codex. A 9 speaker DRT test tape has been made to establish the performance level of the CVSD units before and after the test program. The resulting test tapes, taken before and after the field test program, will be provided to DCEC for evaluation if required.

The Codex CVSD speech coder has been designed to produce the best speech quality achievable with CVSD operating at 16,000 b/s. Appendix A provides information on input-output specifications, CVSD parameters, and operating instructions. The Codex Speech Digitizer advanced development models code speech at rates of 16 and 9.6 kbps using three selectable techniques: adaptive residual coding (ARC), digitally implemented continuously variable slope modulation (CVSD), and adaptive delta modulation (ADM). Only the 16 kb/s CVSD algorithm is required for this test program. The design is implemented on two circuit assemblies and is contained within a standard attache case along with attendant power supply and handset.

The parameters of the units are given as follows:

Input Impedance	600 ohms
Maximum Input Level	3V, p-p
Output Impedance	600 ohms
Maximum Output Level	3V, p-p
Frequency Cut-off	3000 Hz, Transmit and Receive

16 Kb/s CVSD Parameters

1. Time constant of integrator = 8 ms.
2. Time constant of step size filter = 2 ms.
3. Minimum step size = 20 mV.
4. Compression ratio = 166.
5. Effective magnitude of pulse applied to step size filter whenever three successive transmission bits are identical = 280mV.

c. Magnetic Tape Recorder. The magnetic tape recorder used to make the voice recordings well be adjusted/ and or repaired such that its performance parameters are sufficiently good that in the judgement of the Test Director the recording will not be impaired. Suitable frequency response and distortion characteristics will be measured. Further the optimum recording level will be established and a method provided such that the field test team can be assured of recording at the proper level.

d. Halcyon 520B. The Halcyon 520B will be used to characterize every tenth channel measured and those channels where the BER is greater than 10^{-2}. The Halcyon 520B units will be calibrated.

2. Documentation - The documentation shall contain sufficient information to adequately evaluate modem performance. The test documentation for the program shall include the following:

Test Log - One for each station

Test Data Sheets

Test Equipment and Inventory List

Circuit Parameter Test Report

Weekly written status report to the Test Director

Red Flag Reports* as required

a. The Test Log is to be used at every site to record a chronology of events, equipment status, equipment and/or circuit outages, weather conditions, list of test team members, etc., in short everything that may be useful to the evaluating agency.

b. The Data Sheets shall contain all of the pertinent information collected during each test run. They shall include routing information, transmission media configuration, time of test start and finish, synchronization information, bit error rate, block error rate, and whether voice recordings were taken.

c. The Test Equipment Inventory List shall be maintained at each site to show what test equipment was used during testing. The test data sheet entry for test equipment requires only the test equipment number to be entered. A copy of the inventory list must accompany the test data sheet.

---

* Report of emergency conditions that may affect the test performance or schedule.

d. The Circuit Parameter Test Report shall contain the measured data for each circuit so tested. It shall accompany the test data sheet.

e. The Weekly Status Report shall be prepared by the test team leader at each site and submitted to the Test Director by Monday of the next week. It shall contain a narrative summary of the events of the previous week, review the status of the test program, and list any difficulties encountered, etc.

f. Red Flag Reports will only be submitted if difficulties encountered cannot be resolved at the site and require intervention at a higher level, or events/difficulties which result in schedule slippage are encountered. It will be submitted to the Test Director by the test team leader at each site as required. The Test Director will immediately inform organization points of contact the cause and resolution associated with Red Flag Reports.

g. The above documentation will contain the signature of all test team members at each location as concurring with the content of the material therein. Each member will have the opportunity to submit a non-concurrence with supporting rationale. Non concurrence will be reported as Red Flag Reports.

3. Sample Size Required - There may be combination of N carrier, ON carrier, T 12 radio, and VF facilities from the test location to the serving AUTOVON switch. Sufficient testing should be accomplished on each of these facilities and combinations of facilities in tandem to statistically establish a high confidence estimate of the performance over each. To do so it will be necessary to conduct sufficient statistical sampling to provide a level of confidence that the modem performance over each type of access facility, or combinations of facilities in tandem, are characteristic. For the

range of interest ($1 \times 10^{-3} \leq p \leq 1 \times 10^{-2}$), a sequential sampling scheme should be utilized which leads to one of two conclusions:

H_0 testing is sufficient to characterize modem performance at a confidence level of 95%.

H_1 testing is insufficient to characterize modems performance at a confidence level of 95%.

If it is assumed that the mean bit error rate is a normally distributed statistic in accordance with the central limit theorem then:

$$T = \frac{\sum_{i}^{n} - \overline{X}_i}{\sqrt{n} \sqrt{\sum_{i} - \sigma_i^2}}$$

where: T = the Student's T distribution function

$\overline{X}_i$ = mean BER of each test run

σ_i^2 = variance of BER of each test call

n = number of test calls

Sufficient tests should be conducted to achieve a confidence level of 95% for characteristic modem performance on each test configuration. If time limitations preclude achievement of the 95% confidence level, the test director shall note what degree of confidence was achieved on the data sheet. Instructions and data to apply this statistical procedure is provided in Appendix B.

4. Miscellaneous Consideration - The ground rules for the operational testing will be as follows:

a. In order to prevent excessive pre-emption, the caller will use the highest precedence authorized by the local commander.

b. In order to prevent the possibility of dialing a circuit equipped with echo suppressors, the prefix 11 (one-one) will be used for each call.

c. If the circuit is pre-empted while a test call is in progress, the call shall not be considered as a valid call.

d. Companders - Where companders are included in the access line, the modem should be tested over a representative sample of these lines to determine what effects the nonlinear characteristics of the companders will have on modem performance.

e. Single Frequency (SF) Signalling Units - The SF units used on the AUTOVON subscriber access lines are of the Model E2B and E3B variety. The amplifiers of these SF units also introduce nonlinear characteristics into the circuit. When harmonic distortion over the access line drops below 30 dB for either 2nd or 3rd harmonic, the SF units should be checked to determine whether they are the source of the difficulty.

V. Test Requirements:

A minimum of 40 test calls will be made each day between test locations. AUTOVON testing will be conducted during the first two days of testing at each test location. Each AUTOVON call will be conducted through a series of up to five known tandem switches using "dial-through" capability of the AUTOVON. In this way the modem will be exercised over a number of tandem circuits representative of those normally used during an actual secure voice call. [illegible] be [illegible]cted [illegible] The equipment will be configured as shown in Figure 11. The modems will be connected through 4-wire AUTOVON access line and local Bell access line, and will be configured for operation with the transmit output set at -13 dBm0. Testing will be performed in both directions of transmission on every attempt over the AUTOVON and Bell Networks. Prior to on-line testing each day the modems will be pretested to ensure the modems are operating properly.

A detailed flow diagram of the test sequence is shown in Figure 12. The general testing sequence is as follows:

a. Establish Call - Exercise analog tandeming on AUTOVON calls using the "dial through" capability in accordance with Table 2 through Table 4.

b. Assign Test Number to Call - A test number will be assigned to each call placed over the AUTOVON or DDD system. For any particular day, the number will be sequential starting with the number 1. In addition, a Suffix A will be assigned to data taken at the Pentagon and a B to the outlying station. In addition, if the line has been characterized, a "C" will be assigned. If voice recordings were also made, an additional suffix "R" will be used.

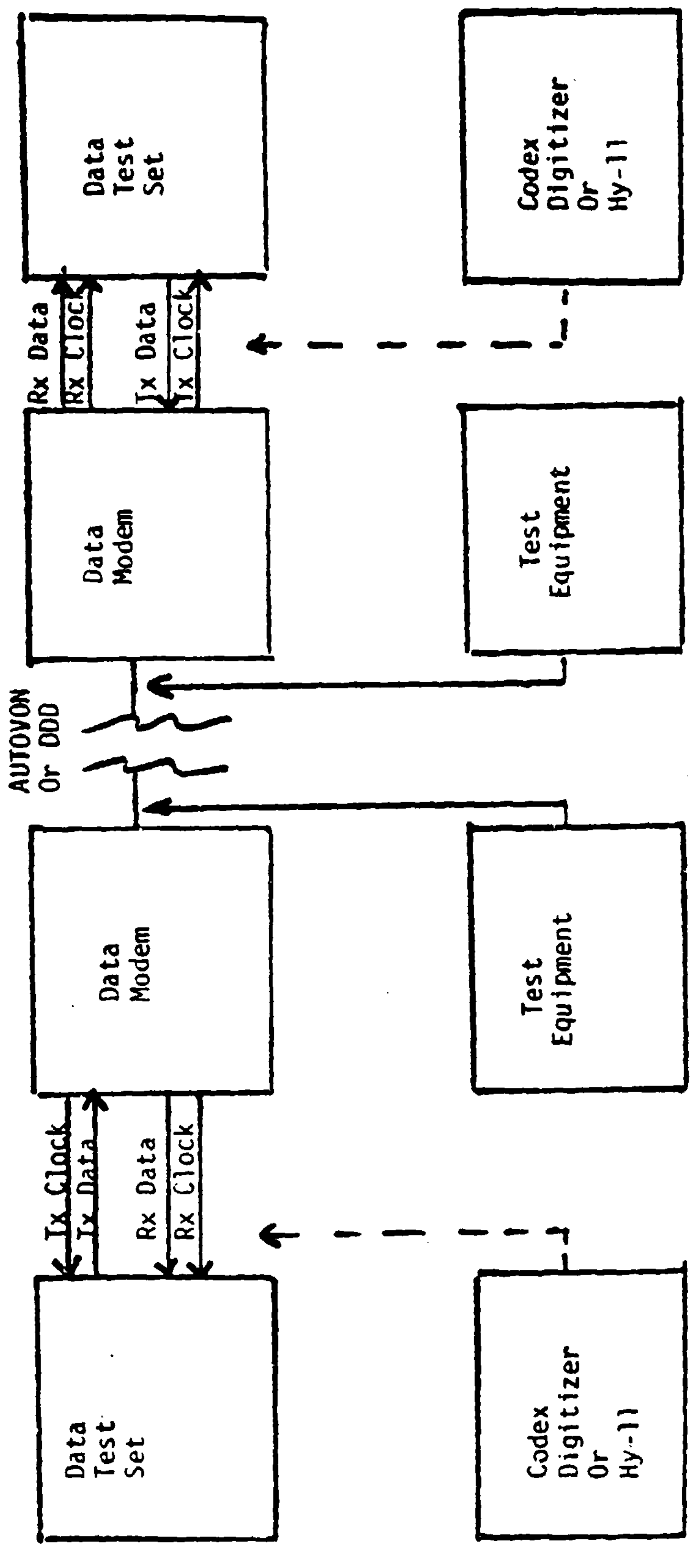

FIGURE 11

MODEM TEST EQUIPMENT CONFIGURATION

Example: 3ACR-081645Z April refers to the 3rd call from the Pentagon, made at 1845 hours (zulu) on the 8th of May. It was characterized as well as recorded.

c. Connect and Synchronize 16 Kb/s Modem - Each test call will verify the ability of the 16 Kb/s Modem to synchronize with the 16 Kb/s Modem at the distant test location. Synchronization attempts will be continued until two consecutive successful synchronizations occur up to a maximum of ten attempts. If synchronization fails (i.e., inability to sync-up two consecutive times within ten tries), the circuit will be characterized and the 9600 Modem and the 16 Kb/s Modem (operating in the 8 kb/s mode) tested over the same circuit. The same synchronization test will be used. Procedure will follow flow chart shown in Figure 12. If the modem synchronizes at 16 kb/s, 10% of the l[illegible]s will be characterized in a manner explained below. The BER will be measured on all these synchronized lines. If the BER is less than .1%, the next call will be placed. If the BER is greater or equal to .1%, the lines not previously characterized will be tested and attempts will be made to synchronize two consecutive times out of ten at 8 kb/s. Those successful will have a BER test made and recorded. Next, attempts will be made to synchronize two consecutive times out of ten at 9.6 kb/s. Similarly BER test will be made and recorded, and the same process repeated at 2.4 kb/s. This latter test concludes the test on the line in question and the next call may be attempted.

1. Bit Error Rate Measurements - All BER tests will be logged on the Bit Error Rate Data Sheet, Figure 13. All blocks at the top of the sheet will be completed prior to using the test sheet. Normally the transmit level will be adjusted to -13 dBm0 while the receive level will be measured and

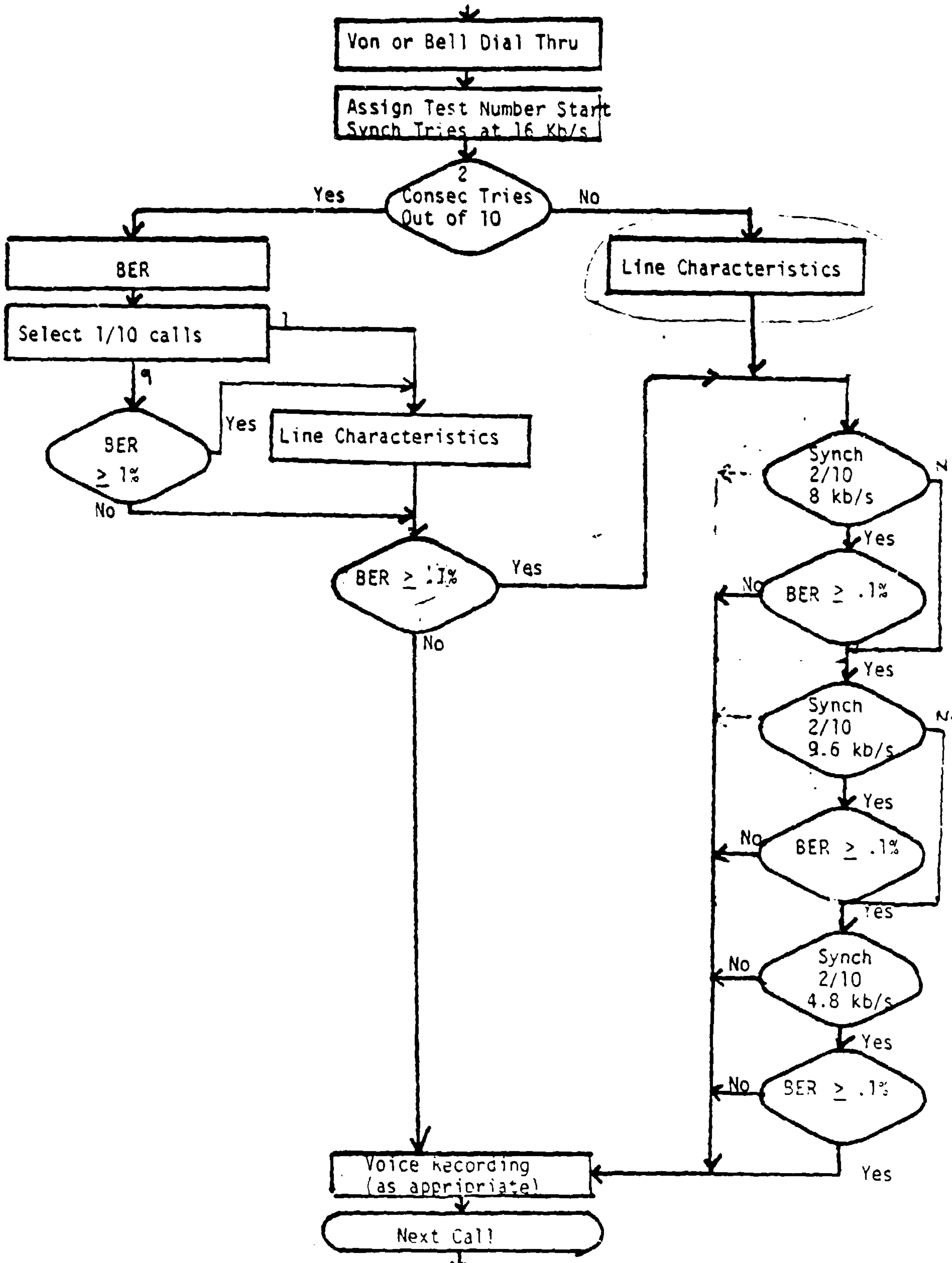

FIGURE 12. VF MODEM TEST FLOW CHART

Bit Error Test Data | Link No. | Page ____ of ____ Pages

Station Tested: | Distant Station: | DATE /TIME GROUP

TEST POINTS: TX/VF ____ TLP ____ -dBm | RFC ____ TLP ____ -dBm

MUX RECORDER

BERT Pattern Length:

TEST ENGR UNIT | TEST TECH I.

		START	STOP	TX DATA LEVEL	RX DATA LEVEL	BIT RATE	NO. BITS TRANS	NO. OF ERRORS	AV BIT ERROR RATE	NO. BLOCKS TRANS	NO. OF ERRORS	AV BLOCK ERROR RATE	SETTINGS NO. BIT ERRORS FOR 1 BLOCK ERROR	[illegible]	REMARKS (Cross reference by call # and date time group)

entered prior to starting the run. If a line characterization is also made, cross reference should be made in the remarks column to the pertinent Line Characterization Data Sheet. The following chart will be used in setting up the BER tester:

Bit Rate	Block Size	Test Run Duration
16 KBS	1000 Bits	4800 Blocks
8 KBS	1000 Bits	2400 Blocks
9.6 KBS	1000 Bits	2400 Blocks
4.8 KBS	1000 Bits	1200 Blocks

In addition, the tester dial should be set so that if one error occurs in a block, the block will be counted in error. The BER is defined as the number of bits in error during a run divided by the total number of bits transmitted during the run. The Block Error Rate is the number of blocks in error divided by the number of blocks transmitted.

Bit Error Rate Vs. Transmtt Level -For every category of circuits, a sampling should be made to determine whether the BER is affected by the transmit level of the modem into the line. This test should be made on a line which has been characterized. The transmit level should be adjusted in 3 dB steps from -19 dBm0 to -7 dBm0. (In the event these settings are not available on the modem, the nearest settings should be used). A plot of BER versus level in dBm0 will complete this phase of the test.

2. Channel Characterization - (For further information refer to DCAC 300-175-9, December 1977). Those lines which are to be characterized will be entered on the Line Characterization Data Sheet (Figure 14). The following parameters will be measured:

Line Characterization Data Sheet		Call or Test No.	Page of Pages
Link No.	Station Tested	Distant Station	Date/Time Group
TLP	Routing		Test Engr Initials

1. Levels: Xmt Test Tone_____-dBm Rx Test tone______-dBm Loss______dB
   Xmt Data ______-dBm Rx Data ______-dBm Loss______dB

2. Noise: Rx flat __________dBm _________dBrn0 Rx"C"_____dBrnC ______dBrnC0
   Rx Signal to "C" notched noise. Rx"C"_____dBrnC ______dBrnC0
   S/N flat________dB S/N "C" ___________dB

3. Nonlinear: 2nd order________dB. 3rd order__________dB.
   Harmonic: 2nd order________dB. 3rd order__________dB.

4. Phase Jitter: __________ ^{o}Pk/Pk. Spectrum components page______.
   Phase Hits (15 min)______ Gain Hits (15 mins)________ Dropouts (15 min)___

5. Impulse Noise:_______in 15 min>71 dBrnC0. _____>75 dBrnC0. _____ >79 dBrnC0.

6. Cross Talk: __________ -dBm __________Hz

7. Singe Tone Interference: ___________-dBm __________Hz.

8. Frequency Translation: +____Hz. -_____Hz.

9/10 Frequency Response/Envelope Delay: Indicate page numbers of X-Y plot, or plot below.

9. Frequency Response				10. Envelope Delay Normaled to Min. Delay.			
300 ________	DB	2000 ________	DB	500 ________	µS	2000 ________	µS
500 ________	DB	2200 ________	DB	600 ________	µS	2200 ________	µS
600 ________	DB	2400 ________	DB	800 ________	µS	2400 ________	µS
800 ________	DB	2500 ________	DB	1000 ________	µS	2500 ________	µS
1000 ________	DB			1200 ________	µS		
1200 ________	DB	2700 ________	DB	1400 ________	µS	2700 ________	µS
1400 ________	DB	2800 ________	DB	1600 ________	µS	2800 ________	µS
1600 ________	DB	3000 ________	DB	1800 ________	µS	3000 ________	µS
1800 ________	DB	3200 ________	DB				

11. BER: Cross reference to Bit Error Rate Test Data Sheet.

12. Remarks:

FIGURE 14. LINE CHARACTERIZATION DATA SHEET

(a) Level. It is important to be aware of the prescribed level at the transmit and receive port of the circuit. The test tone of -10 dBm0 and a composite data level of -13 dBm0 should be entered at the transmit port. At the receive port, the levels should also be -10 and -13. If this is not the case, the line will have a loss, and if the loss cannot be corrected, a correction is necessary to the instrument readings.

(b) Noise. Both "C" and flat noise should be logged in absolute values and in values referenced to the TLP. The signal-to-noise ratio will be the ratio of the data signal to the measured noise. Additional values of "C" notched noise may be recorded at the direction of the test director.

(c) Non-Linear Distortion. Non-linear distortion is normally made with test equipment designed for the purpose. A pair of frequencies centered at 860 Hz and another pair at 1380 Hz are mixed at a composite level of -13 dBm0 and passed through the circuit. At the receive port, the second order components 520 and 2240 Hz are measured as well as the third level component 1900 Hz. In the event a non-linear test set is unavailable, or if additional tests of this type are considered desirable, a Harmonic Distortion Test may be desirable. In this test a 700 Hz tone at -10 dBm0 is passed through the system and the 2nd, 3rd and 4th harmonics are measured and normalized against the level of the received 700 Hz tone.

(d) Phase Jitter, Phase Hits, Gain Hits and Dropouts - Phase jitter will be indicated in degrees peak-to-peak. Phase hits will be the number of hits in 15 minutes which are greater than 4 ms and also are greater than 20° peak. Gain hits will be the number of hits in 15 minutes which are greater than 4 ms and also are greater than ± 3 dB or ± 4 dB. Each category should be indicated. Dropouts will be the number of gain losses in 15 minutes which are greater than 10 ms and also are greater than 12 dB.

(e) Impulse Noise. The number of hits in 15 minutes registered on an Impulse Noise Counter set to 71 dBrnC0. If additional thresholds are available, these may be set above 71 (e.g., 75 and 79).

(f) Cross Talk and Single Tone Interference. A sweep should be made through the receive bandwidth using a frequency selective voltmeter. The frequency of all tones whose level is at least 3 dB below the noise level should be noted.

(g) Frequency Translation. Using frequency counters at each end of the circuit, the translation up or down should be noted.

(h) Frequency Response and Envelope Delay. If X-Y plots are made, they should be referenced by call number and date time group.

(i) Bit Error Rate. The BER entry should be referenced by call number and date time group.

3. <u>Simulation Tests</u>

During the simulation tests which will be held at NSA, eight lines will be utilized as follows.

a. CONUS Poor Voice Grade

b. CONUS Median Voice Grade

c. CONUS Poor Data Grade

d. CONUS Median Data Grade

e. Europe Poor Voice Grade

f. Europe Median Voice Grade

g. Europe Poor Data Grade

h. Europe Median Data Grade

These channels were based on numerous RADC field tests. The characterization of the channels are shown in Figures 15 to 25. When the NSA simulator is programed for the channel characteristics, the Halcyon 520B units used in the field test will be used to validate the simulated parameters.

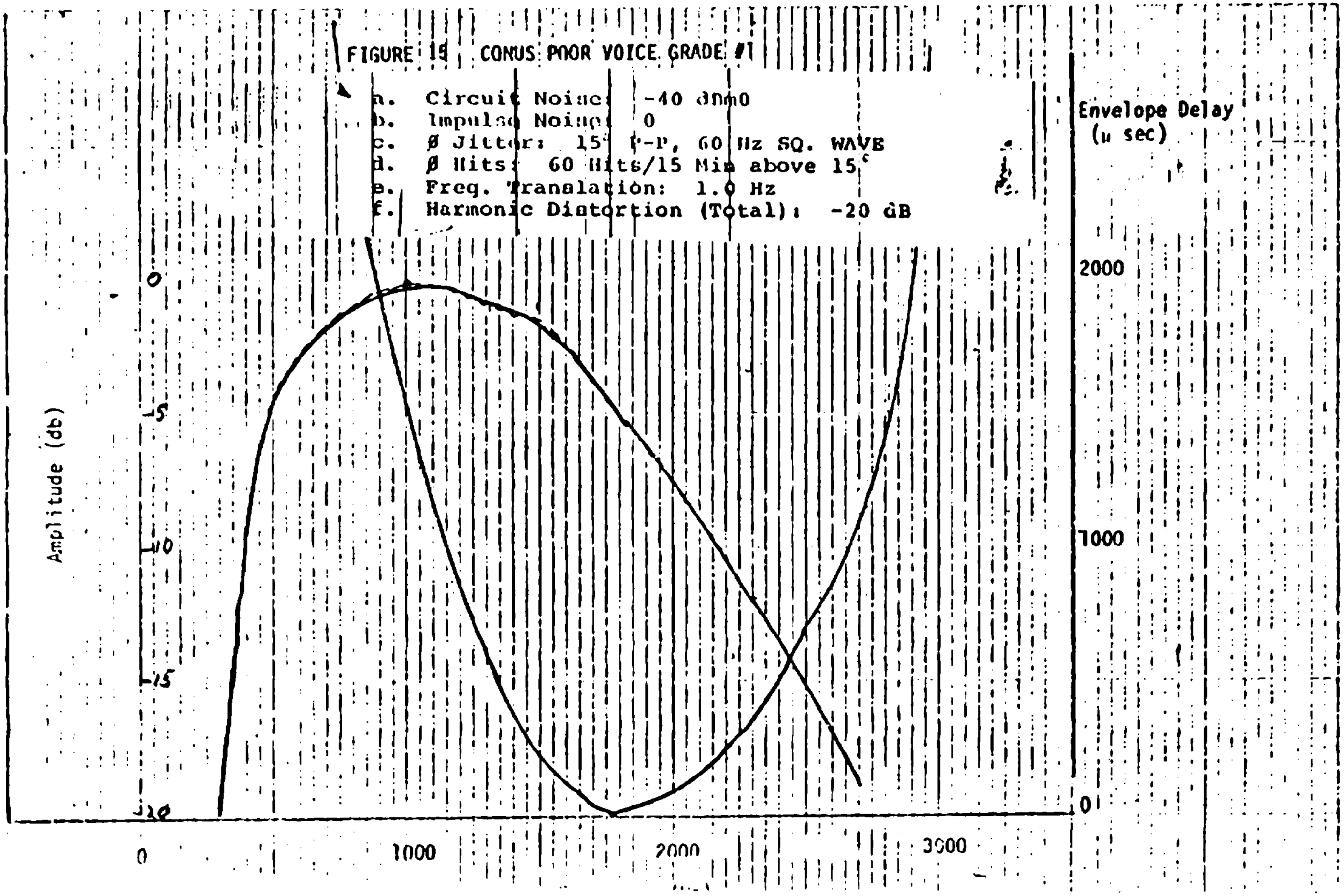
FIGURE 15 CONUS POOR VOICE GRADE #1
a. Circuit Noise: -40 dBm0
b. Impulse Noise: 0
c. ø Jitter: 15° P-P, 60 Hz SQ. WAVE
d. ø Hits: 60 Hits/15 Min above 15°
e. Freq. Translation: 1.0 Hz
f. Harmonic Distortion (Total): -20 dB
Envelope Delay (μ sec)
2000
1000
0
Amplitude (db)
0
-5
-10
-15
-20
0
1000
2000
3000

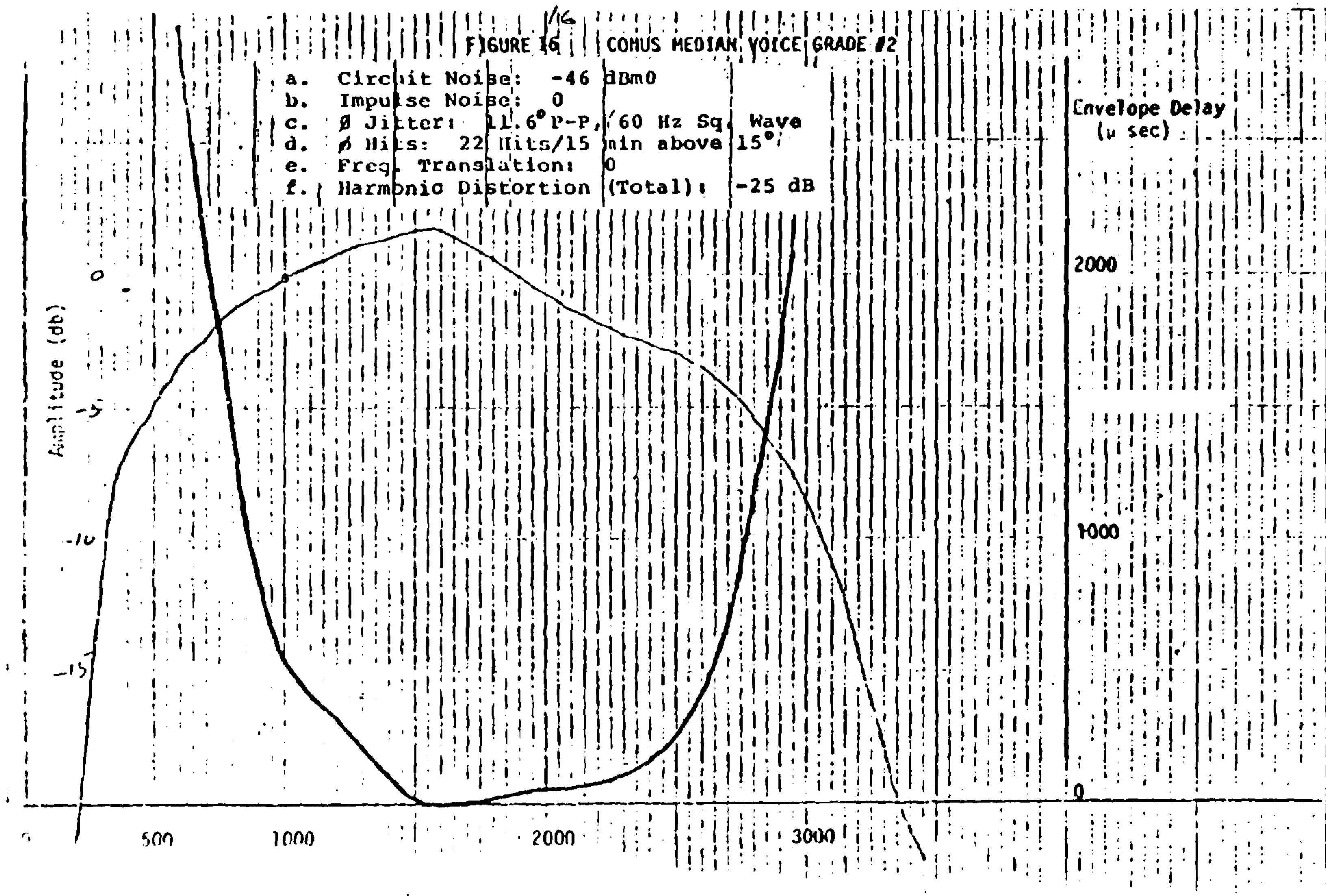

FIGURE 16 CONUS MEDIAN VOICE GRADE #2

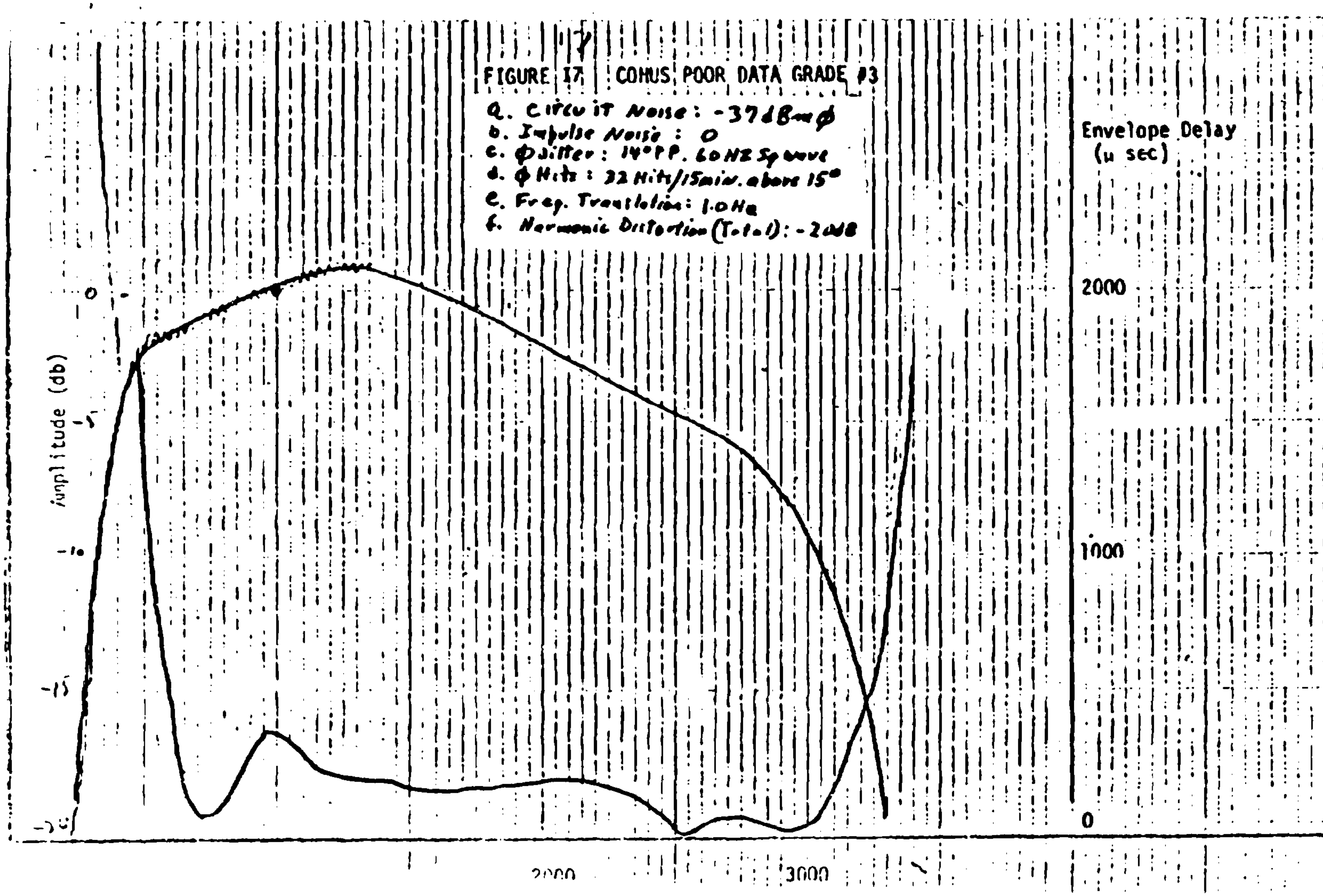

FIGURE 17 COHUS POOR DATA GRADE #3

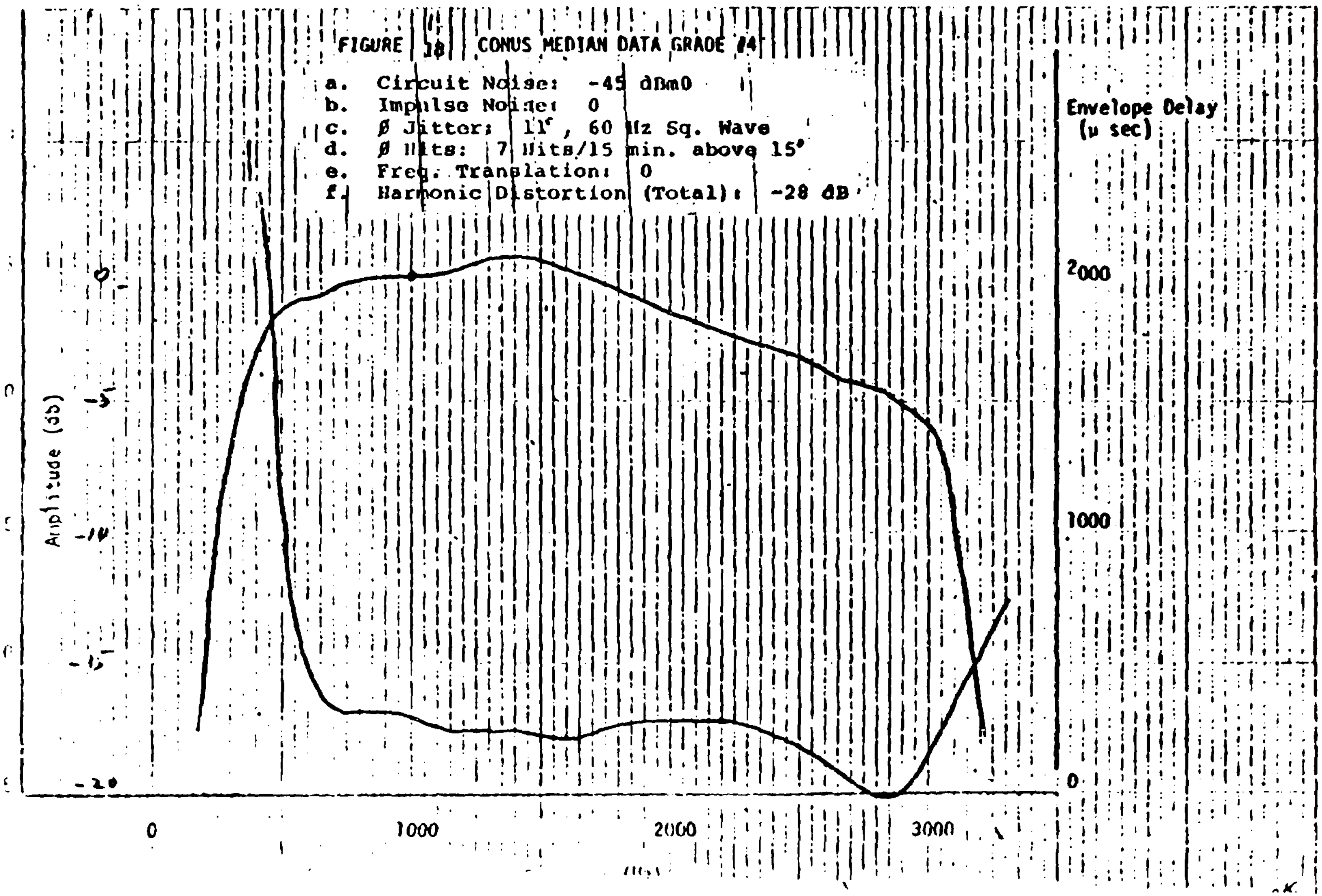

FIGURE 18 CONUS MEDIAN DATA GRADE #4

a. Circuit Noise: -45 dBm0
b. Impulse Noise: 0
c. Ø Jitter: 11°, 60 Hz Sq. Wave
d. Ø Hits: 7 Hits/15 min. above 15°
e. Freq. Translation: 0
f. Harmonic Distortion (Total): -28 dB

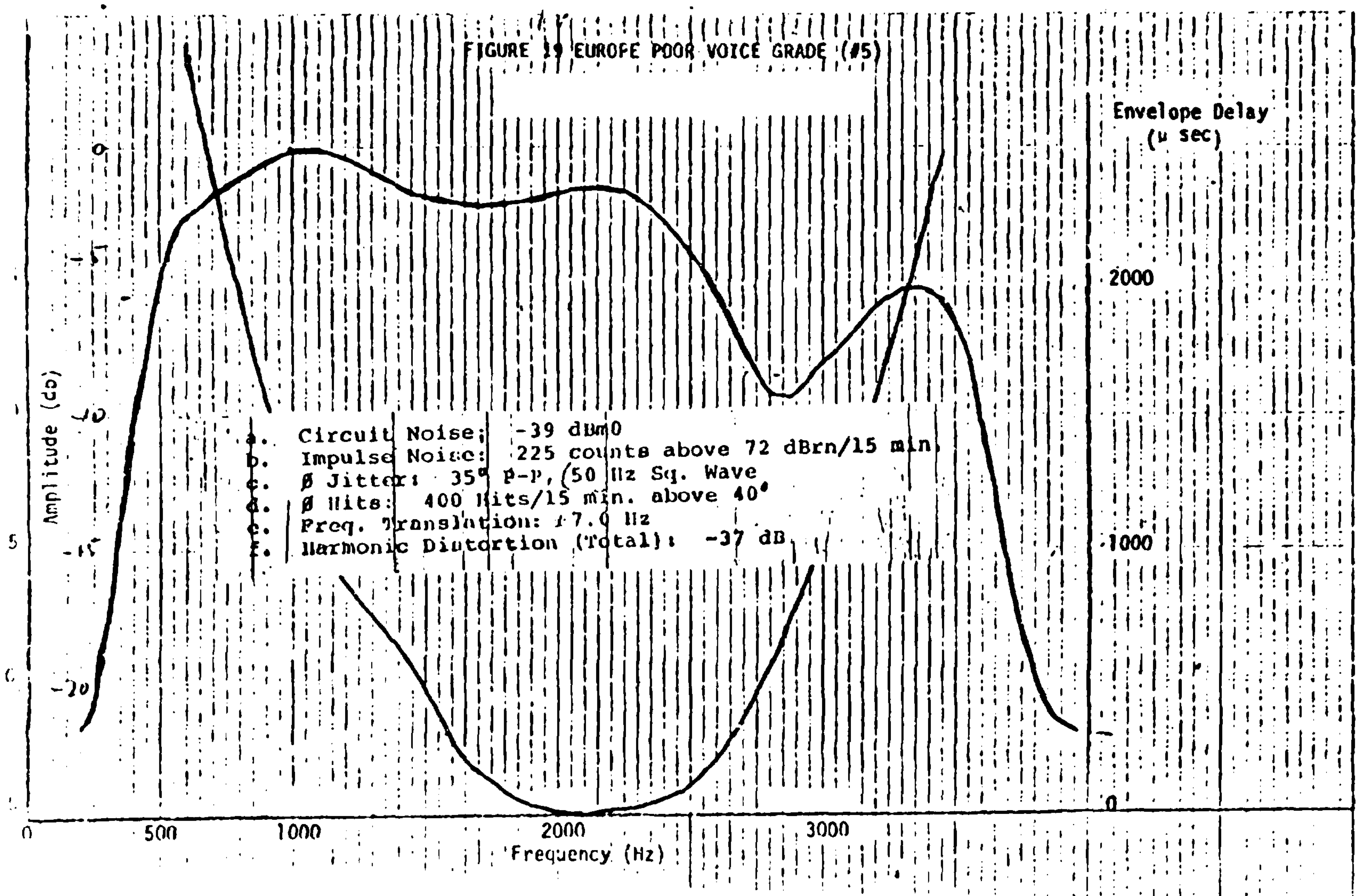

FIGURE 19 EUROPE POOR VOICE GRADE (#5)

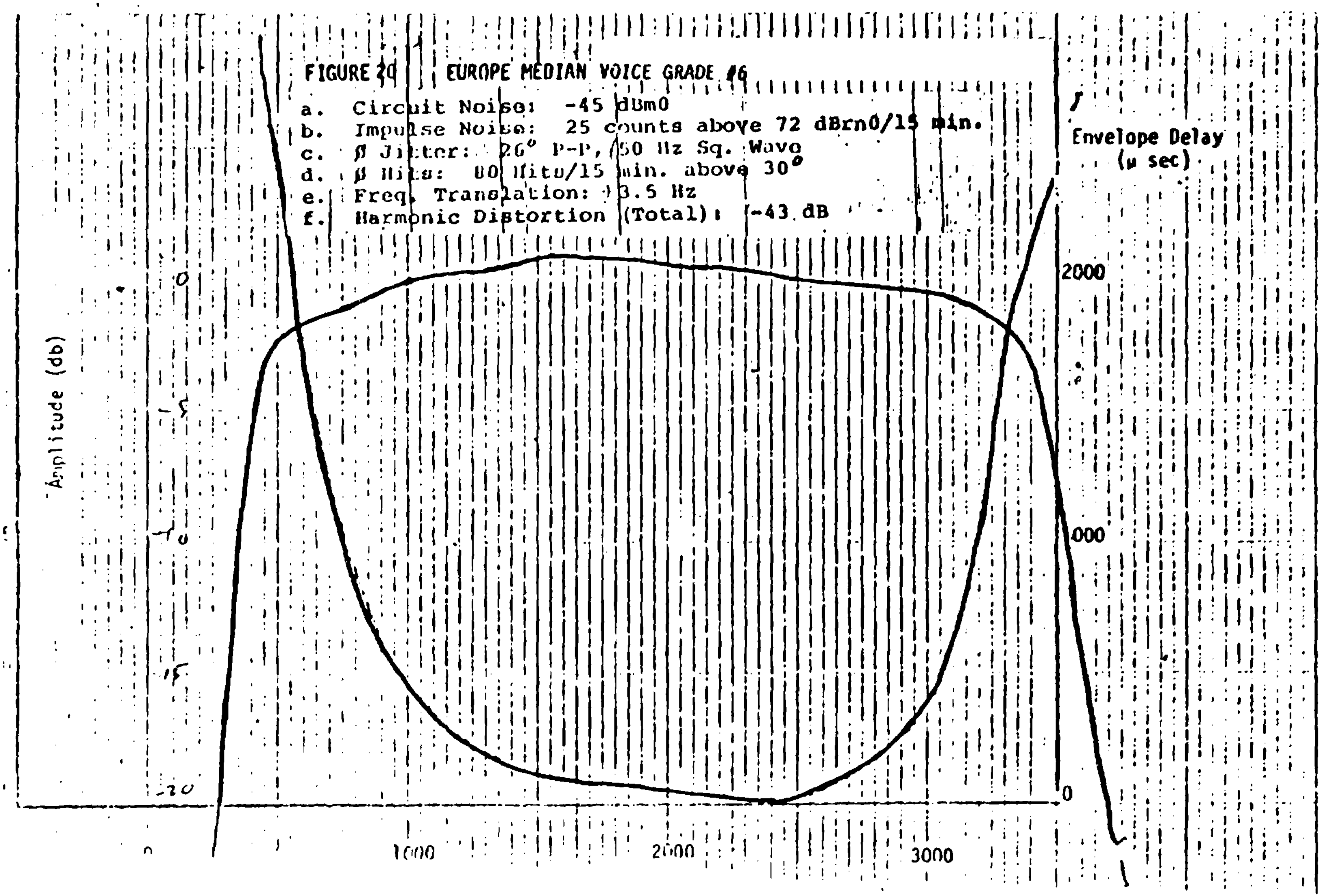

FIGURE 20 EUROPE MEDIAN VOICE GRADE #6

a. Circuit Noise: -45 dBm0
b. Impulse Noise: 25 counts above 72 dBrn0/15 min.
c. Ø Jitter: 26° P-P, 50 Hz Sq. Wave
d. Ø Hits: 80 Hits/15 min. above 30°
e. Freq. Translation: 3.5 Hz
f. Harmonic Distortion (Total): -43 dB

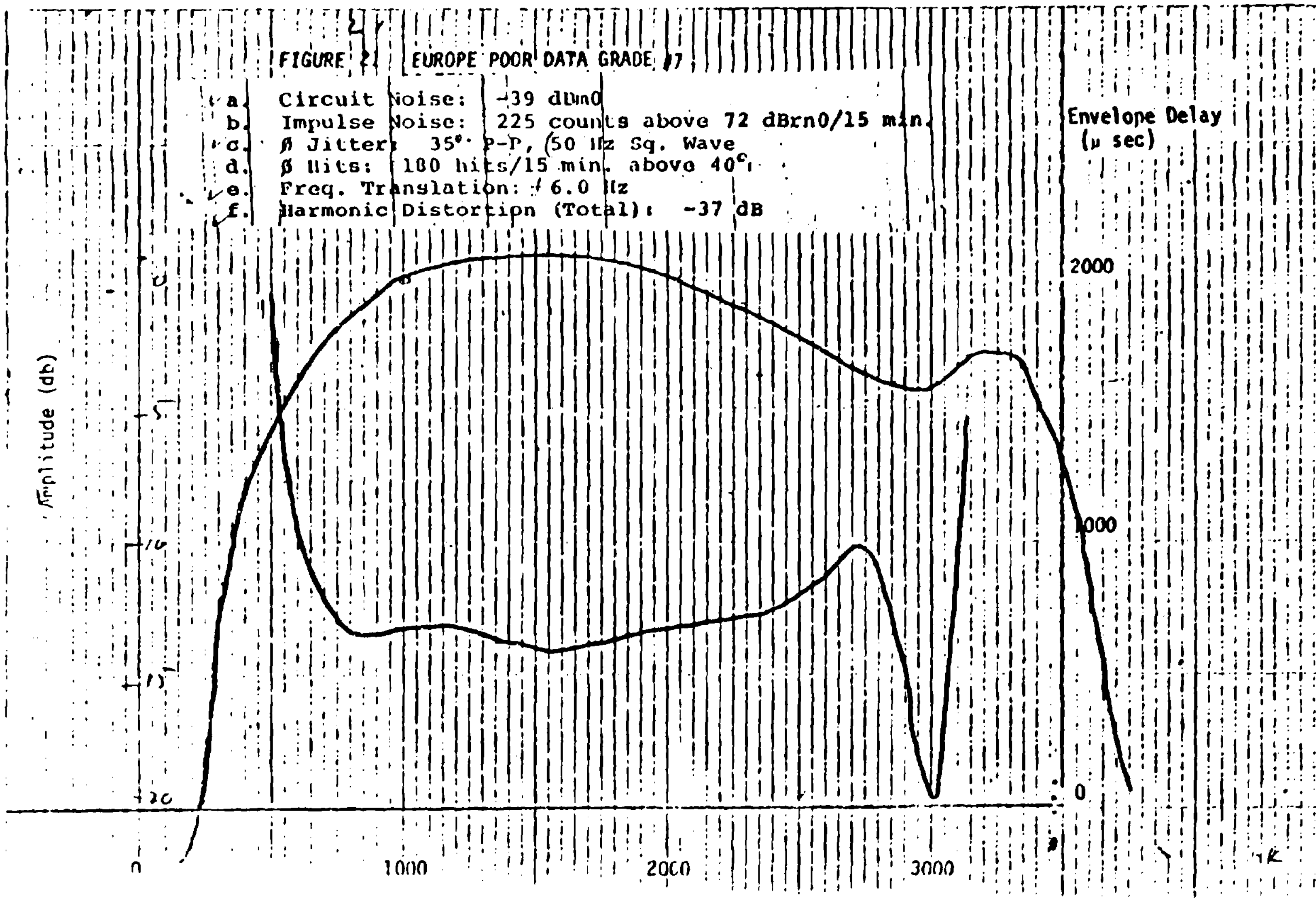

FIGURE 2 EUROPE POOR DATA GRADE #7

a. Circuit Noise: -39 dBm0
b. Impulse Noise: 225 counts above 72 dBrn0/15 min.
c. ∅ Jitter: 35° P-P, (50 Hz Sq. Wave
d. ∅ Hits: 100 hits/15 min. above 40°
e. Freq. Translation: ± 6.0 Hz
f. Harmonic Distortion (Total): -37 dB

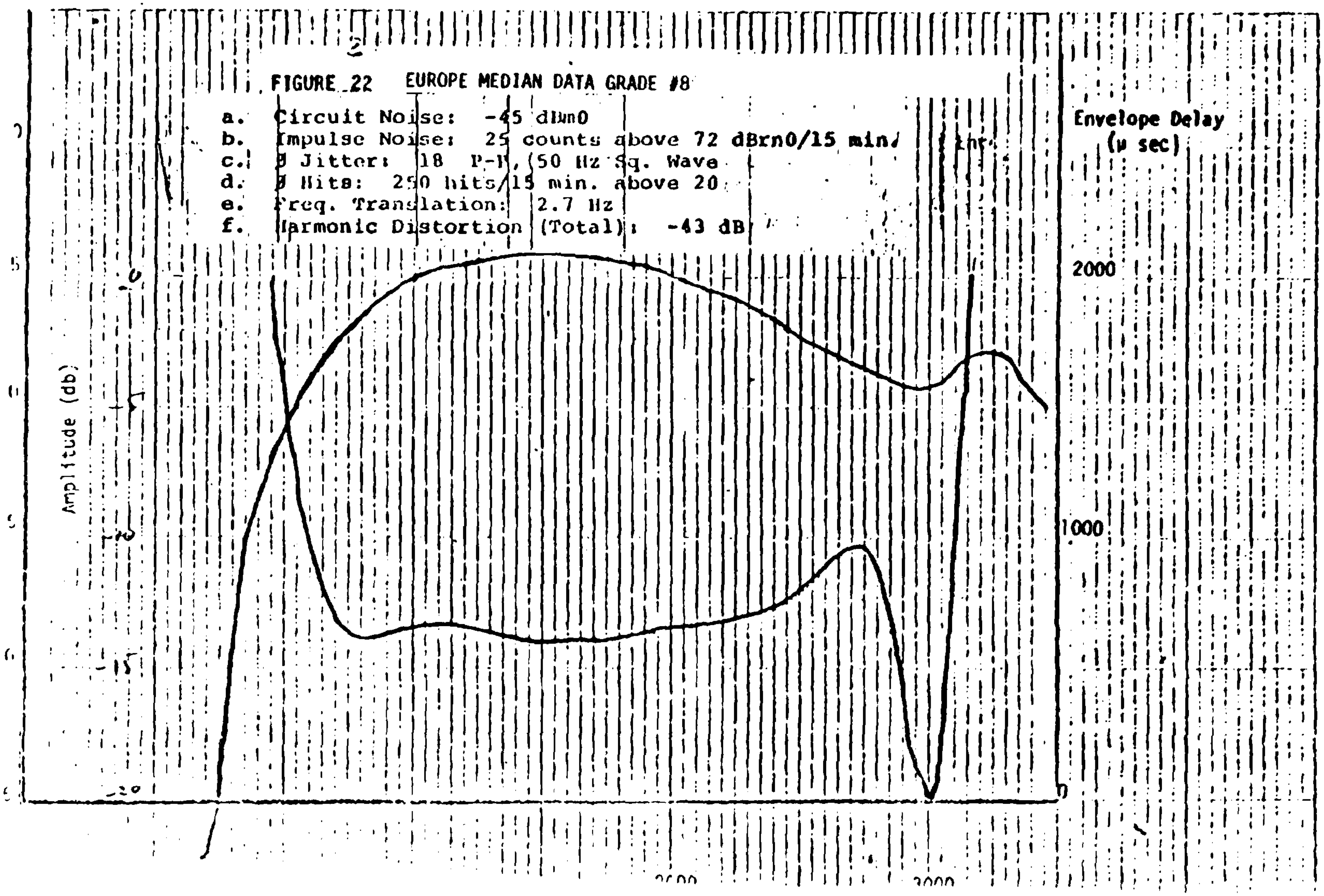

FIGURE 22 EUROPE MEDIAN DATA GRADE #8

a. Circuit Noise: -45 dBm0
b. Impulse Noise: 25 counts above 72 dBrn0/15 min.
c. Ø Jitter: 18 P-P, (50 Hz Sq. Wave
d. Ø Hits: 250 hits/15 min. above 20
e. Freq. Translation: 2.7 Hz
f. Harmonic Distortion (Total): -43 dB

4. Recording of Speech on the Voice Channel

A sampling will also be made of voice quality over a representative number of lines which have been tested for BER characterized.

The recording will consist of 12 PAR sentences spoken by 6 speakers. Each set of 12 sentences is preceded by a 8 sec of 1000 hz tone to set the recording level. The recorded speech will be identified by an announcement consisting of the call number and date/time group at the beginning and end of the sentences.

The line level will be adjusted so that a 0 dBmØ test tone will cause the receive VU meter to read 0. Subsequent speech will cause the meter to exceed the OVU level only at rare intervals. Tape speed should be 3 3/4 inches/second. The tape container should also be labeled with the call number and date/time group.

5. Tandem Switch Test

The interswitch trunk (IST) tests will be performed according to the following procedures:

a. The distant end (i.e. Offutt AFB, March AFB or McDill AFB) will originate all calls to the near end, the Pentagon or Ft. Meade. The rationale for this procedure is to permit closer control of the routing of the call.

b. The eight-hour test day will be divided into two general sections: a five-hour section encompassing the busy hour and the two-hour periods before and after the busy hour. It is requested that the series of calls for this five-hour span be performed in the order specified in the tables.

The second section consists of the three remaining hours of the test day. These test hours (A,B, or C) may be performed in any desired sequence.

c. The first week of testing should be used to verify the operation of the modem over the AUTOVON IST's, therefore the IST tests between McDill AFB and the Pentagon should be run in their entirety. Selected sampling of each call length (no. of links) may be done during the second and third weeks of testing.

CALL DISTRIBUTION

LINKS	SWITCHES	CALLS	%
1	2	16	33.3
2	3	14	29.2
3	4	10	20.8
4	5	5	10.4
5	6	3	6.3
		48	100.0

SWITCH ABBREVIATIONS

ARL - Arlington, VA
DRA - Dranesville, VA
ELL - Ellisville, FLA
FVW - Fairview, KAN
JAS - Jasper, ALA
JUL - Julian, CAL
LYO - Lyons, NEB
MOJ - Mojave, CAL
MOS - Moseley, VA
NOR - Norway, ILL
POL - Polk City, FLA
POT - Pottstown, PA
ROC - Rockdale, GA
SEG - Seguine, TEX
SLO - St. Louis Obispo, CAL
YAK - Yakima, WASH

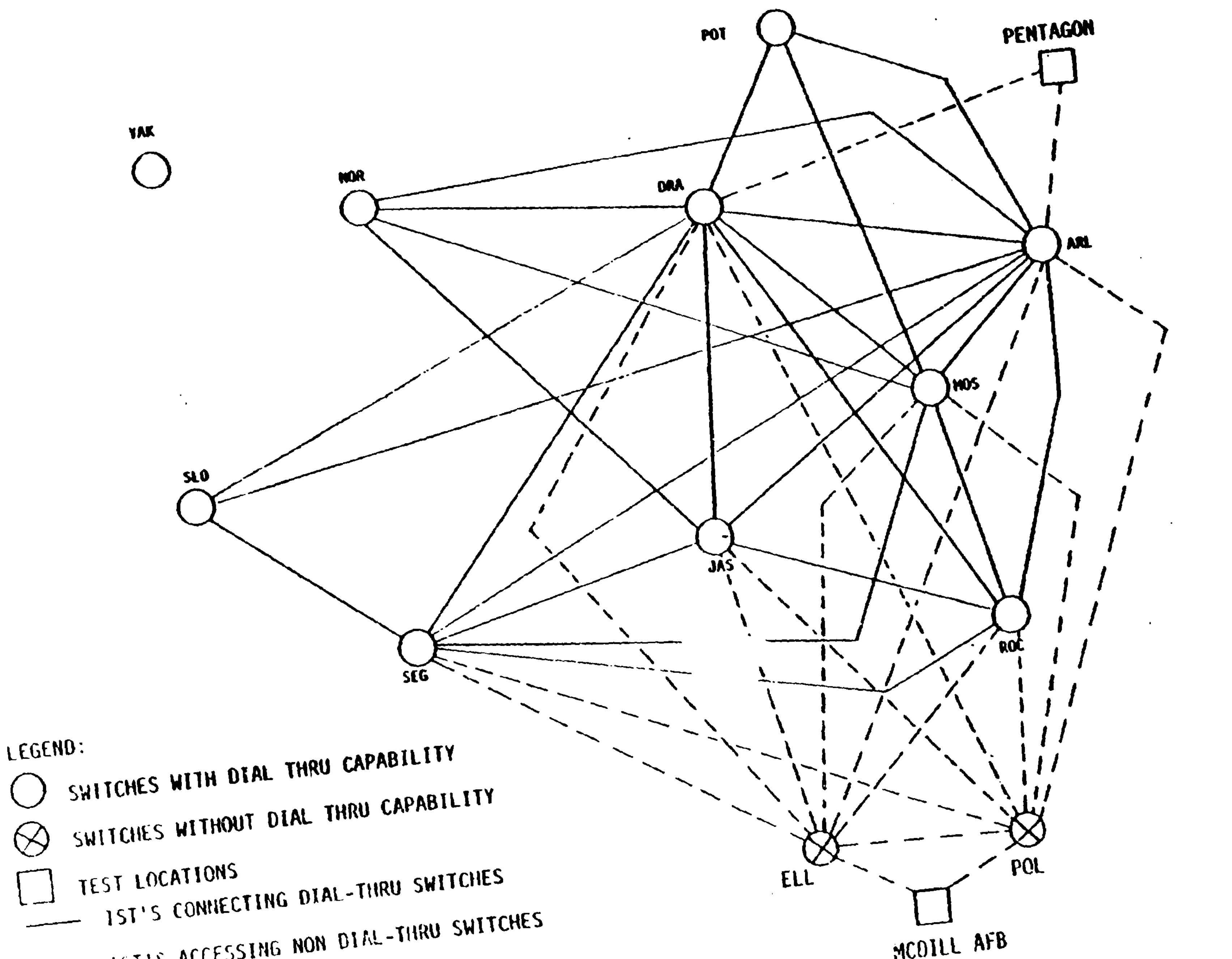
PENTAGON
POT
YAK
NOR
DRA
ARL
MOS
SLO
JAS
ROC
SEG
ELL
POL
MCOILL AFB
LEGEND:
SWITCHES WITH DIAL THRU CAPABILITY
SWITCHES WITHOUT DIAL THRU CAPABILITY
TEST LOCATIONS
IST'S CONNECTING DIAL-THRU SWITCHES
IST'S ACCESSING NON DIAL-THRU SWITCHES

FIGURE 23

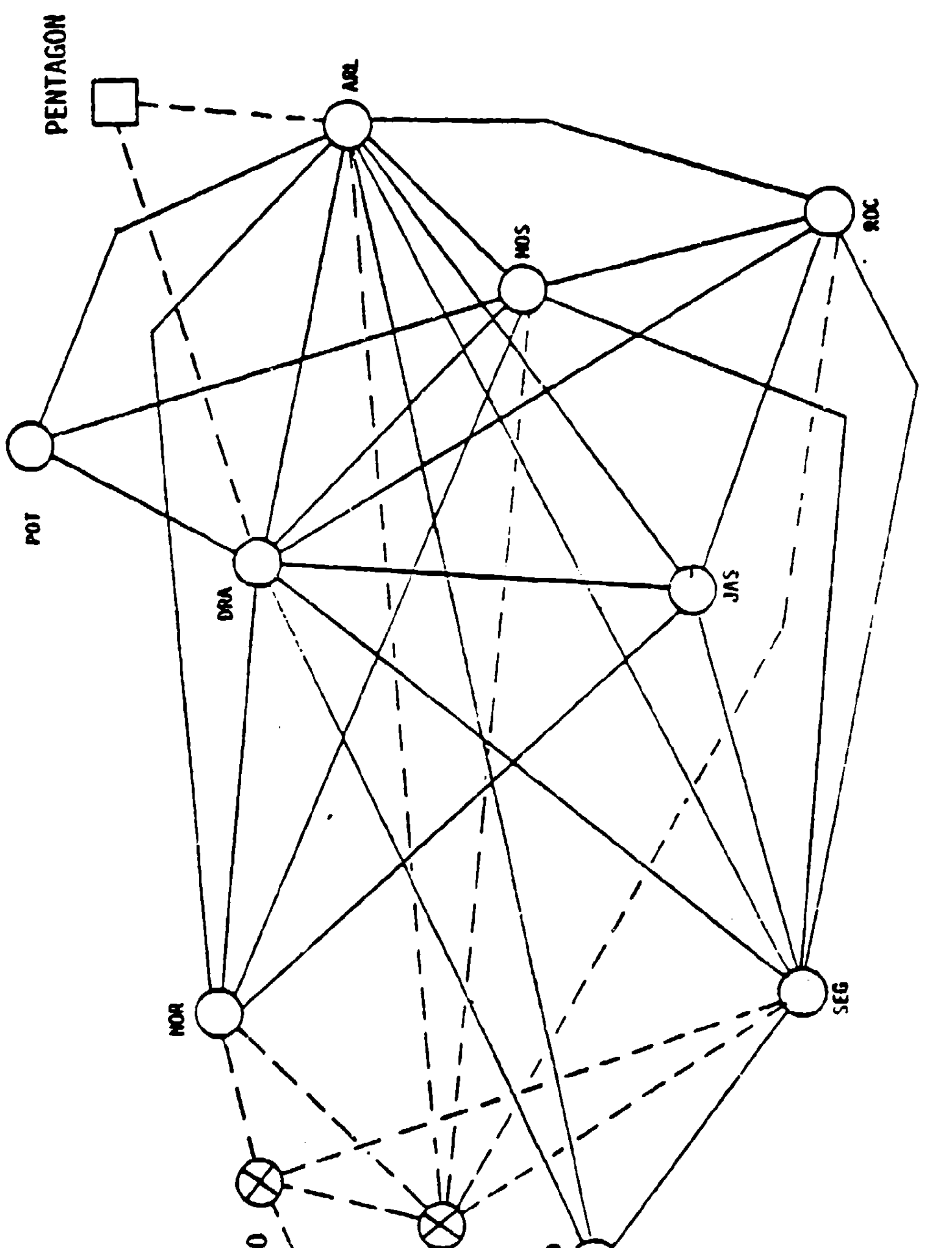
PENTAGON
ARL
MOS
ROC
POT
DRA
JAS
NOR
SEG
LYO
FVW
SLO
YAK
OFFUTT AFB

FIGURE 24

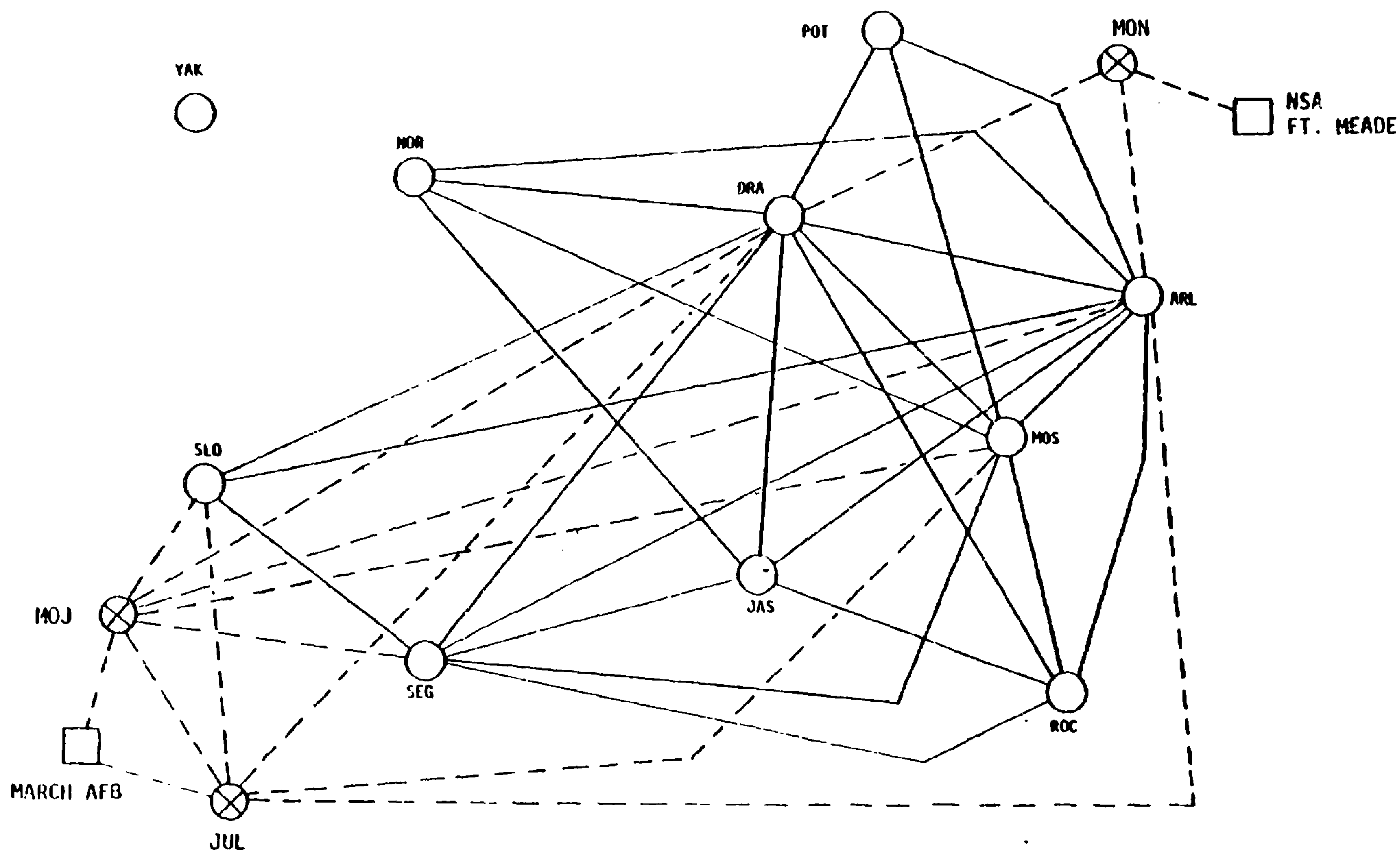
YAK
NOR
POT
MON
NSA
FT. MEADE
DRA
ARL
MOS
SLO
JAS
MOJ
SEG
ROC
MARCH AFB
JUL

FIGURE 25

TABLE 2

TEST BETWEEN MC DILL AFB and PENTAGON DATE

TRAFFIC HOUR	CALL NUMBER	ROUTE EACH CALL THROUGH THE NAMED SWITCH LOCATIONS 1	2	3	4	5	6	CHK ✓
	A 1	ELL	ARL					
	A 2	ELL	ROC	ARL				
A	A 3	ELL	ROC	SLG	JAS	ARL		
	A 4	ELL	ARL					
	A 5	ELL	HOS	ARL				
	A 6	ELL	SEG	JAS	ARL			
	1	ELL	ARL					
TWO HOURS	2	ELL	SEG	ARL				
PRIOR TO	3	ELL	SEG	SLO	YAK	NOR	ARL	
BUSY HOUR	4	ELL	ARL					
	5	ELL	JAS	ARL				
	6	ELL	JAS	ROC	ARL			
	7	ELL	DRA					
ONE HOUR	8	ELL	RUC	DRA				
PRIOR TO	9	ELL	RUC	HOS	POT	DRA		
BUSY HOUR	10	ELL	DRA					
	11	ELL	HOS	DRA				
	12	ELL	SEG	JAS	DRA			
	13	ELL	DRA					
	14	ELL	JAS	DRA				
BUSY HOUR	15	ELL	SEG	SLO	YAK	NOR	DRA	
	16	ELL	DRA					
	17	ELL	SEG	DRA				
	18	ELL	ROC	HOS	DRA			

TABLE 2 (Continued)

TEST BETWEEN MC GILL AFB and PENTAGON DATE

TRAFFIC HOUR	CALL NUMBER	1	2	3	4	5	6	CHK. ✓
ONE HOUR AFTER BUSY HOUR	19	POL	DRA					
	20	POL	ROC	DRA				
	21	POL	DAS	MOR	MOS	DRA		
	22	POL	DRA					
	23	POL	MOS	DRA				
	24	POL	DAS	DRA				
TWO HOURS AFTER BUSY HOUR	25	POL	DRA					
	26	POL	SEG	DRA				
	27	POL	DAS	SEG	ARL	DRA		
	28	POL	DRA					
	29	POL	ARL	DRA				
	30	POL	ROC	DRA				
B	B-1	POL	ARL					
	B-2	POL	ROC	ARL				
	B-3	POL	DAS	MOR	MOS	ARL		
	B-4	POL	ARL					
	B-5	POL	[illegible]	ARL				
	B-6	POL	ROC	DAS	ARL			
C	C-1	POL	ARL					
	C-2	POL	DAS	ARL				
	C-3	POL	ROC	DAS	SEG	SEG	ARL	
	C-4	POL	ARL					
	C-5	POL	SEG	ARL				
	C-6	POL	MOS	ROT	ARL			

TABLE 3

TEST BETWEEN DEFUIT AFB and PENTAGON DATE

TRAFFIC HOUR	CALL NUMBER	ROUTE EACH CALL THROUGH THE NAMED SWITCH LOCATIONS 1	2	3	4	5	6	CHK ✓
A	A 1	VW	ARL					
	A 2	VW	NOR	ARL				
	A 3	VW	NOR	JAS	ROC	ARL		
	A 4	VW	ARL					
	A 5	VW	MOS	ARL				
	A 6	VW	NOR	JAS	ARL			
TWO HOURS PRIOR TO BUSY HOUR	1	VW	ARL					
	2	VW	SEG	ARL				
	3	VW	YAK	NOR	JAS	DRA	ARL	
	4	VW	ARL					
	5	VW	ROC	ARL				
	6	VW	NOR	MOS	ARL			
ONE HOUR PRIOR TO BUSY HOUR	7	VW	NOR	DRA				
	8	VW	SEG	JAS	DRA			
	9	VW	NOR	JAS	ROC	DRA		
	10	VW	MOS	DRA				
	11	VW	MOS	POT	DRA			
	12	VW	MOS	NIK	JAS	DRA		
BUSY HOUR	13	VW	SEG	DRA				
	14	VW	ROC	MOS	DRA			
	15	VW	YAK	NOR	MOS	POT	DRA	
	16	VW	ROC	DRA				
	17	VW	SEG	MOS	DRA			
	18	VW	SEG	JAS	ROC	DRA		

TEST BETWEEN DEFUIT AFB and PENTAGON DATE

TABLE 3 (CONTINUED)

TRAFFIC HOUR	CALL NUMBER	ROUTE EACH CALL THROUGH THE NAMED SWITCH LOCATIONS 1	2	3	4	5	6	CHK. ✓
ONE HOUR AFTER BUSY HOUR	19	LYO	NOR	DRA				
	20	LYO	SEG	NOS	DRA			
	21	LYO	SEG	JAS	ROC	DRA		
	22	LYO	SEG	DRA				
	23	LYO	SEG	SLO	DRA			
	24	LYO	NOR	ARL	DRA			
TWO HOURS AFTER BUSY HOUR	25	LYO	NOR	DRA				
	26	LYO	SEG	ARL	DRA			
	27	LYO	SEG	NOS	NOR	DRA		
	28	LYO	SEG	DRA				
	29	LYO	NOR	NOS	DRA			
	30	LYO	NOR	JAS	DRA			
B	B-1	LYO	NOR	ARL				
	B-2	LYO	NOR	NOS	ARL			
	B-3	LYO	NOR	NOS	POT	ARL		
	B-4	LYO	SEG	ARL				
	B-5	LYO	NOR	JAS	ARL			
	B-6	LYO	SEG	JAS	ROC	ARL		
C	C-1	LYO	NOR	ARL				
	C-2	LYO	SEG	JAS	ARL			
	C-3	LYO	YAK	NOR	WHA	POT	ARL	
	C-4	LYO	SEG	ARL				
	C-5	LYO	SEG	ROC	ARL			
	C-6	LYO	SEG	NOS	NOR	ARL		

TABLE 4

TEST BETWEEN MARCH AFB AND FT. MEADE DATE

TRAFFIC HOUR	CALL NUMBER	ROUTE EACH CALL THROUGH THE NAMED SWITCH LOCATIONS 1	2	3	4	5	6	CHK ✓
A	A-1	JUL	ARL					
	A-2	JUL	SLO	ARL				
	A-3	JUL	SLO	SIG	ROC	ARL		
	A-4	JUL	ARL					
	A-5	JUL	MOS	ARL				
	A-6	JUL	SLO	DRA	ARL			
TWO HOURS PRIOR TO BUSY HOUR	1	JUL	ARL					
	2	JUL	DRA	ARL				
	3	JUL	SLO	SIG	DRA	POT	ARL	
	4	JUL	ARL					
	5	JUL	SLO	ARL				
	6	JUL	SLO	SIG	ARL			
ONE HOUR PRIOR TO BUSY HOUR	7	JUL	DRA					
	8	JUL	SLO	DRA				
	9	JUL	MOS	JAS	NOR	DRA		
	10	JUL	DRA					
	11	JUL	MOS	DRA				
	12	JUL	SLO	SIG	DRA			
BUSY HOUR	13	JUL	DRA					
	14	JUL	ARL	DRA				
	15	JUL	SLO	YAK	NOR	BOS	DRA	
	16	JUL	DRA					
	17	JUL	SLO	DRA				
	18	JUL	MOS	PIT	DRA			

TABLE 4 (CONTINUED)

TEST BETWEEN MARCH AFB and FT. MEADE DATE

TRAFFIC HOUR	CALL NUMBER	ROUTE EACH CALL THROUGH THE NAMED SWITCH LOCATIONS 1	2	3	4	5	6	CHK. ✓
ONE HOUR AFTER BUSY HOUR	19	MO.	DRA					
	20	MO.	SLO	DRA				
	21	MO.	SEG	ROC	MOS	DRA		
	22	MO.	DRA					
	23	MO.	SEG	JAS	DRA			
	24	MO.	SLO	SEG	DRA			
TWO HOURS AFTER BUSY HOUR	25	MO.	DRA					
	26	MO.	SEG	DRA				
	27	MO.	SLO	SEG	JAS	DRA		
	28	MO.	DRA					
	29	MO.	SEG	ROC	DRA			
	30	MO.	SEG	MOS	DRA			
B	B-1	MO.	ARL					
	B-2	MO.	SLO	ARL				
	B-3	MO.	SEG	JAS	NOR	ARL		
	B-4	MO.	ARL					
	B-5	MO.	MOS	ARL				
	B-6	MO.	SEG	ROC	ARL			
C	C-1	MO.	ARL					
	C-2	MO.	SEG	ARL				
	C-3	MO.	SLO	SEG	JAS	ROC	ARL	
	C-4	MO.	ARL					
	C-5	MO.	DRA	ARL				
	C-6	MO.	SEG	MOS	ARL			

VI Data Collection

Data will be taken to characterize each category of circuits defined by the test plan and in accordance with the test procedures established in Section IV. The tests taken will be as defined by Section V. The tests will be conducted on the following types of circuits.

- AUTOVON Tests
  1. Concentrator Access Lines
  2. Tandem Switches
  3. Subscriber Loops
- Commercial DDD

Since the principal field and hub test locations are at or near concentrators, the concentrator access line test and the tandem switch tests are one way concentrator to concentrator tests. The subscriber loop test, and the commercial DDD tests the modems will be located at potential subscriber locations and therefore, the test results will be representative subscriber to subscriber performance. The concentrator access lines and IST's for the subscriber loop tests cannot be controlled.

For the concentrator access lines and the tandem switch tests and circuits will be made up of various combinations of end link transmission facilities (i.e., D1, D2, D3, ON, N1, N, L, etc.). To interpert the data properly and to use the results to predict the impact on the total system performance, it is essential that the end link facilities be identified as accurately as possible. Each combination of end link transmission facilities will represent a category of circuits to be tested. It is desirable to take sufficient data such that an estimate of the performance of each category can be made. The number of tests required depends upon their availability and the variability of the resulting test data.

Therefore, the number of samples to be taken for each category must be determined by the team leader at the test site. Figure VI - 1, 2, or 3 define each test configuration and possible categories of circuits to be tested. The categories thus defined are based on currently available information. The team leader at the test site will review the transmission facilities available for test and evaluate the accuracy and sufficiency of those shown. At least one modem transmission level test and one voice measurement test will be made for each category of circuits.

Arrangements have been made at Offutt AFB to do test on the UHF radio circuit from ground entry stations through the Airborne Command Post. These tests will be conducted by looping channels at the aircraft by appropriate patch panel connectors.

TABLE 5 PENTAGON TO MCDILL AFB TEST SCHEDULE

	PENTAGON	MCDILL AFB
Monday April 3	1. Set up at AT&T Facilities.	1. Set up in GTE Facilities Building 501.
	2. Review available facilities and select categories of access lines and subscriber loops to be tested.	2. Review available facilities and select categories of access lines and subscriber loops to be tested.
	3. Demonstrate test set up by doing loop tests through Arlington and Dranesville switches.	3. Demonstrate test set up by doing loop tests through Polk City and Ellisville switches.
	4. Initiate calls in first category of access lines to check out procedure.	
	5. Extend call to multiple switch circuits to check out procedure.	
Tuesday April 4	1. Obtain data on each category of concentrator access line to be tested.	
	2. Extend calls to multiple switch calls.	
	3. Continue to take loop test data while McDill move is made.	3. Move test set up from GTE facilities to AUTOSEVOCOM II facilities.
	4. Repeat 1 and 2 above for AUTOSEVOCOM circuits.	
Wednesday April 5	1. Complete concentrator access line and multiple switch tests.	
Thursday April 6 Friday April 7	2. Move to potential user locations and establish calls between McDill and Pentagon. Take prescribed data over circuit with subscriber loops. For each location repeat for DDD call.	2. Move to potential user locations and establish single IST circuit. Take prescribed data over circuit with subscriber loops. Repeat for DDD call.
	3. Continue to take loop test data.	3. Upon completion of testing data on all categories of circuits, pack and move to Offutt AFB.

TABLE 6 PENTAGON TO OFFUTT AFB TEST SCHEDULE

	PENTAGON	OFFUTT AFB
Monday April 10	1. Continue to gather data on access line loops and multi switch trunk tests.	1. Set up in Telco facilities.
	2. Open	2. Review available facilities and select categories of access line and subscriber loops to be tested.
	3. Open	3. Demonstrate test setup by doing loop test through Lyons and Fairview switches.
	4. Initiate calls for first category of access lines to check out procedures and site survey problem with SF Units on Fairview access lines.	
	5. Extend calls to multi-switch circuits to check out procedure.	
Tuesday April 11	1. Obtain data on each category of AUTOVON Concentractor Access Lines.	
	2. Extend calls to multiple switch calls.	
	3. Continue to take loop test data while Offutt move is made.	3. Move to AUTOSEVOCOM I facilities. Set up and do loop test via ground entry station through Airborne Command Post.
	4. Repeat 1 and 2 above for AUTOSEVOCOM I Access Line.	
Wednesday April 12	1. Complete concentrator access line and multiple switch tests.	
Thursday April 13 Friday April 14	2. Move to potential subscriber location and establish calls. Take prescribed data over circuits with subscriber loops. For each location repeat for DDD calls.	2. Move to potential subscriber locations and establish calls. Take prescribed data over circuits with subscriber loop. For each location repeat for DDD calls.
	3. Upon completion of tests, pack and move to NSA Ft. Meade.	3. Upon completion of tests, pack and move to March AFB.

TABLE 7 NSA FT. MEADE TO MARCH AFB TEST SCHEDULE

<table>
<tr><th></th><th>NSA FT. MEADE</th><th>MARCH AFB</th></tr>
<tr><td>Monday
April 17</td><td>1. Set up at NSA Ft. Meade T-Comm Facilities.</td><td>1. Set up in Telco Facilities.</td></tr>
<tr><td></td><td>2. Review available facilities and select categories of access lines and subscriber loops to be tested.</td><td>2. Review available facilities and select categories of access lines and subscriber loops to be tested.</td></tr>
<tr><td></td><td>3. Demonstrate test set up by doing loop tests through Monrovia and Arlington Switches.</td><td>3. Demonstrate test set up by doing loop through Mojave and Julian Switches.</td></tr>
<tr><td></td><td colspan="2">4. Initiate calls on first category of access lines to checkout procedure.</td></tr>
<tr><td></td><td colspan="2">5. Extend calls to multiple switch circuits to check out procedures.</td></tr>
<tr><td>Tuesday
April 18</td><td colspan="2">1. Obtain data on each category of AUTOVON Concentrator Access Lines.</td></tr>
<tr><td></td><td colspan="2">2. Extend calls to multihop switch calls.</td></tr>
<tr><td></td><td>3. Take loop test data while March AFB move is made</td><td>3. Move to AUTOSEVOCOM I facilities. Set up and do switch loop tests through Mojave and Julian switches</td></tr>
<tr><td></td><td colspan="2">4. Repeat 1 and 2 above for AUTOSEVOCOM I access line.</td></tr>
<tr><td>Wednesday
April 19</td><td colspan="2">1. Complete concentrator access line and multiple switch tests.</td></tr>
<tr><td>Thursday
April 20

Friday
April 21</td><td>2. Move to potential subscriber locations and establish calls. Take prescribed data over circuits with subscriber loops. For each location repeat for DDD calls.</td><td>2. Move to potential subscriber locations and establish calls. Take prescribed data over circuit with subscriber loops. For each location repeat for DDD call.</td></tr>
<tr><td></td><td>3. Upon completion of tests, pack and move to NSA Friendship Annex.</td><td>3. Upon completion of tests, pack and move to NSA Friendship Annex.</td></tr>
</table>

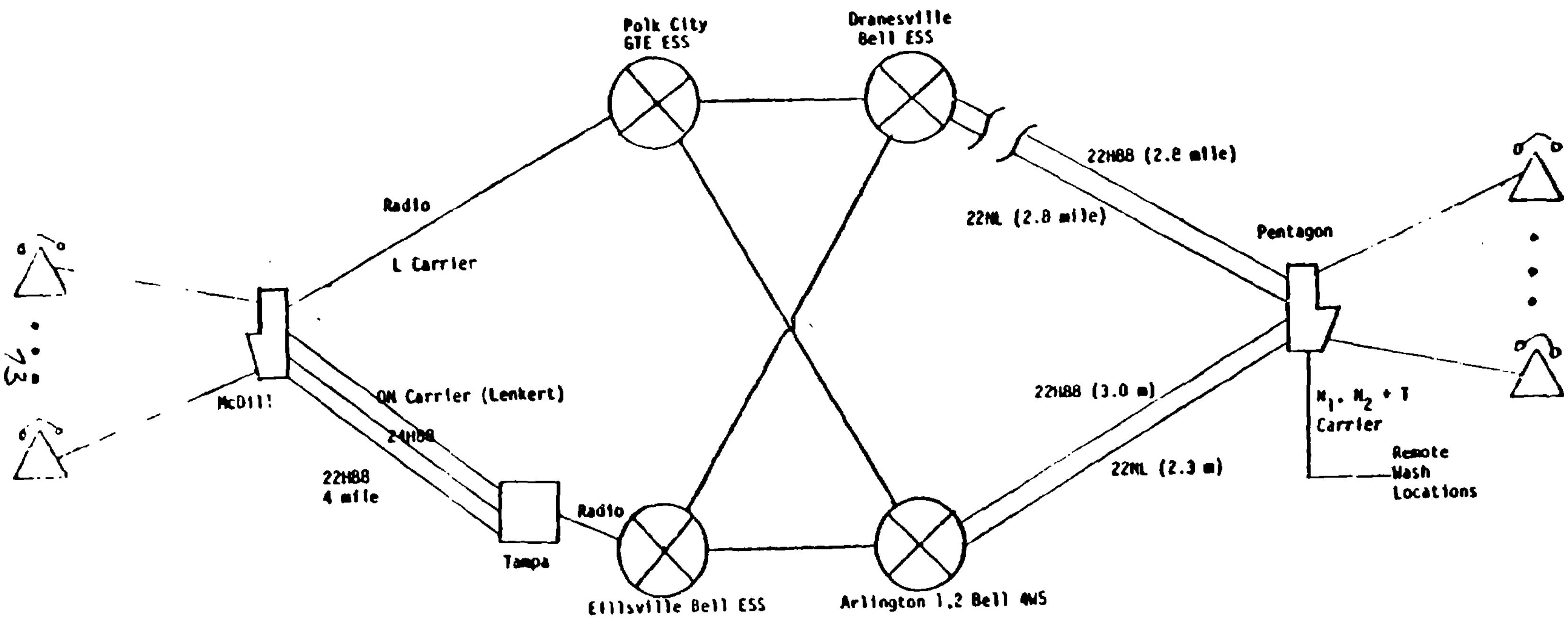

FIGURE 26 MCDILL TO PENTAGON TEST CONFIGURATION

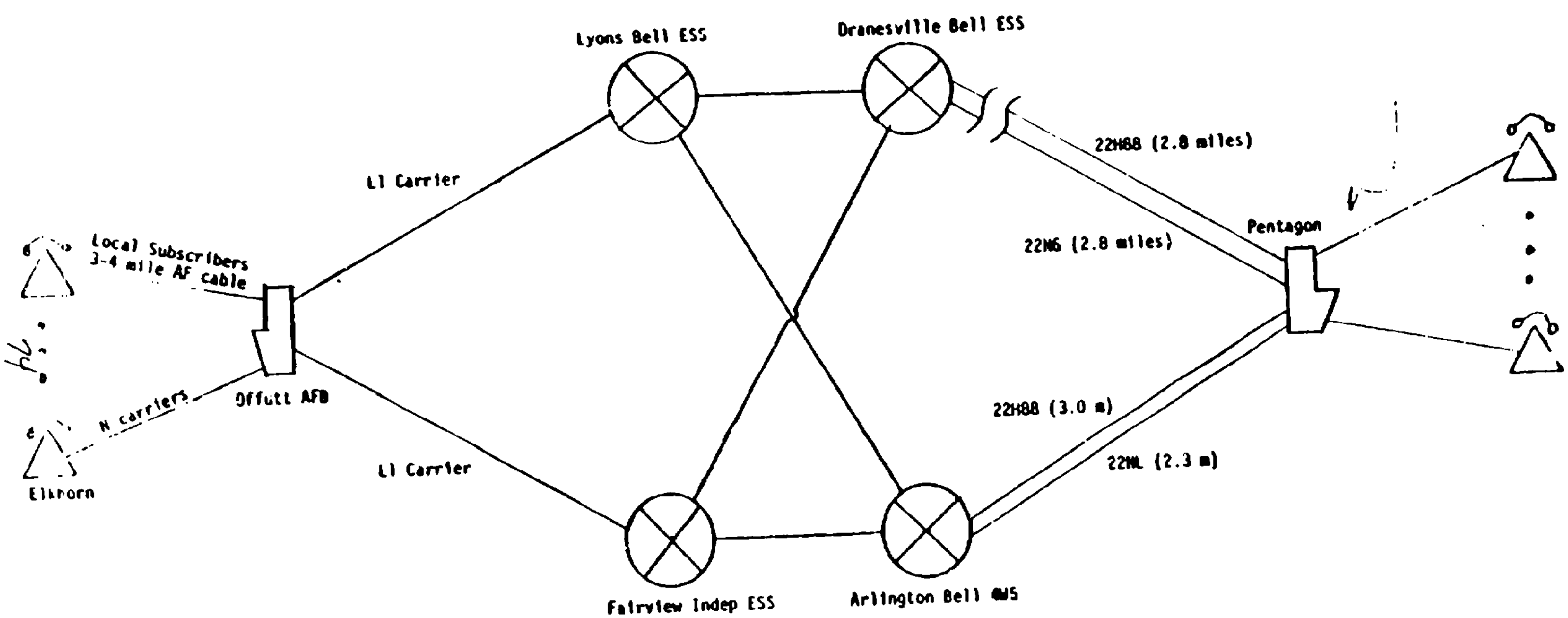

FIGURE 27 OFFUTT AFB TO PENTAGON TEST CONFIGURATION

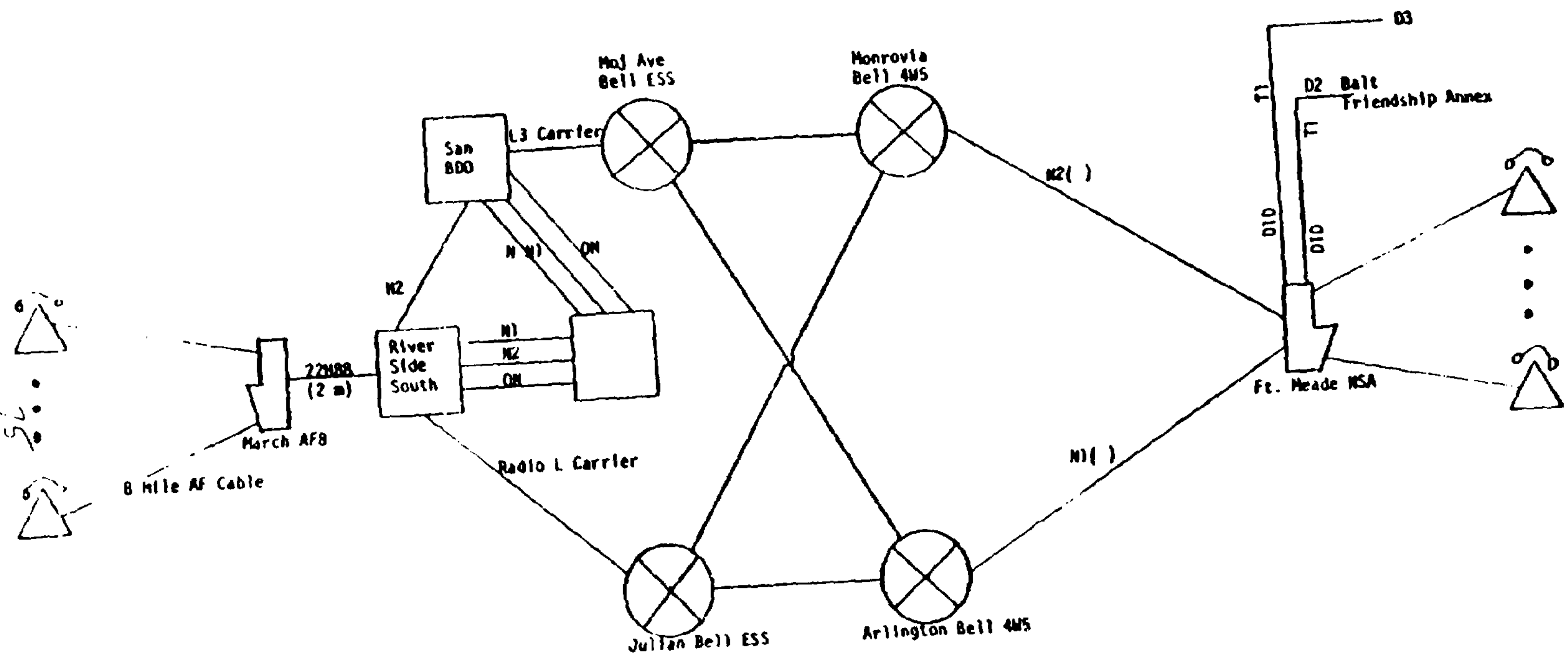

FIGURE 28 MARCH AFB TO FT. MEADE NSA TEST CONFIGURATION

APPENDIX A

CODEX SPEECH DIGITIZER OPERATION

A.1 GENERAL

This appendix contains a functional description of the input/output signals, and controls instructions for operating the Codex Speech Digitizer.

A.2 I/O SIGNALS, CONTROLS AND INDICATORS

Table 4-1 lists the input-output signals carried via connectors located on the panel. The relevant pin numbers and a brief description of the signals is also given in Table 4-1. All signals on the 25-pin connector are of the EIA type for direct connection to the proper modem EIA connector. The EIA outputs are also suitable for directly driving the corresponding inputs on another ARC via a crossover cable as shown in Figure 4-1.

The input and output impedances of the audio circuits are approximately 600Ω. When using an audio source other than the supplied telephone handset, tape recorder IN switch should be turned ON and the input signal level should be adjusted to be less than 2.2 volts peak-to-peak. The audio output may be switched independently between the handset and a tape recorder.

Table 4-2 lists all the control switches available on the Codex speech digitizer with a brief description of the function of each switch. As shown in Figure 4-2 the LOOPBACK switch connects the local ARC transmttter and receiver back-to-back thus permitting the unit to be functionally tested in an isolated environment. If both tape recorder switches are OFF (handset connected) then in the LOOPBACK configuration one can listen to one's own voice after it has been digitized and reconstructed.

TABLE A-1 INPUT-OUTPUT SIGNALS

SIGNAL NAME	TYPE	LOCATION	DESCRIPTION
Protective Ground (AA)	MIL 188	J7-1	Chassis ground. Isolated from Signal Ground (AB) in the ARC.
Signal Ground (AB)	MIL 188	J7-7	Common signal and dc power supply ground. Isolated from protective ground (AA) in the ARC.
Transmit Output Data (BA)	MIL 188	J7-2	Serial binary data with transitions on the positive-going transitions of the internal transmit clock (DA) or a modem supplied clock (DB) (selectable by toggle switch on A4 card).
Receive Input Data (BB)	MIL 188	J7-3	Serial binary data from a modem or directly from an ARC transmitter. Data transitions must occur on the positive-going transitions of the accompanying clock(DD).
Request to Send (CA) (output)	MIL 188	J7-4	Constantly held at a positive level to indicate that data transmission is desired.
Data Terminal Ready (CD) (output)	MIL 188	J7-20	Constantly held at a positive level.
Transmit Signal Element Timing(DA) (output)	MIL 188	J7-24	A serial data rate clock with positive transitions corresponding to data (BA) transitions.
External Transmit Serial Clock (DB) (input)	MIL 188	J7-15	A data rate clock from a modem. When selected by the toggle switch on A4 card the data (BA) transitions will occur on positive-going transitions of this clock (DB).
Receive Signal Element Timing (DD) (input)	MIL 188	J7-17	Data rate clock accompanying the receive data (BB).

TABLE A-1 (continued)

Voice in	Audio	RCA phono Jack (IN)	Audio input (to be digitized) from tape recorder
Voice Out	Audio	RCA phono Jack (OUT)	Audio output reconstructed by the ARC

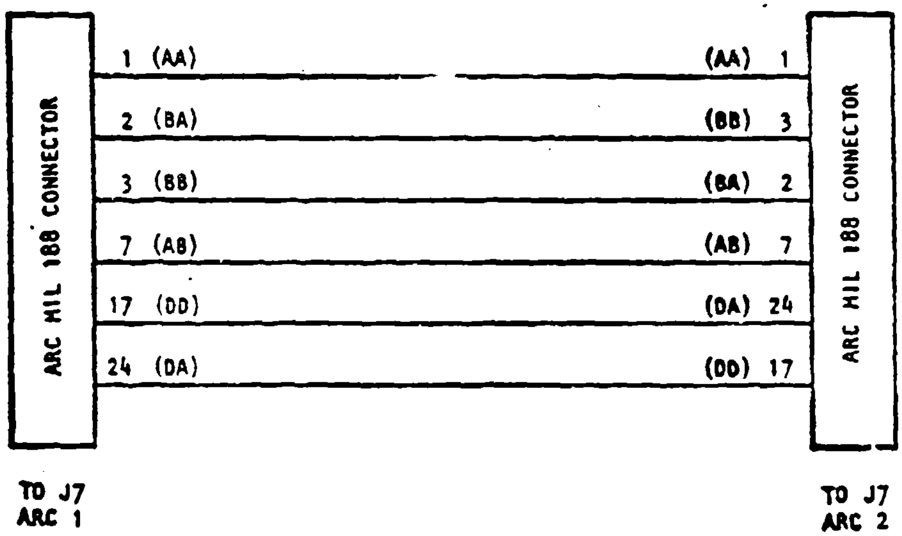

FIGURE A-1

CROSSOVER CABLE FOR DIRECTLY CONNECTING TWO ARC's.

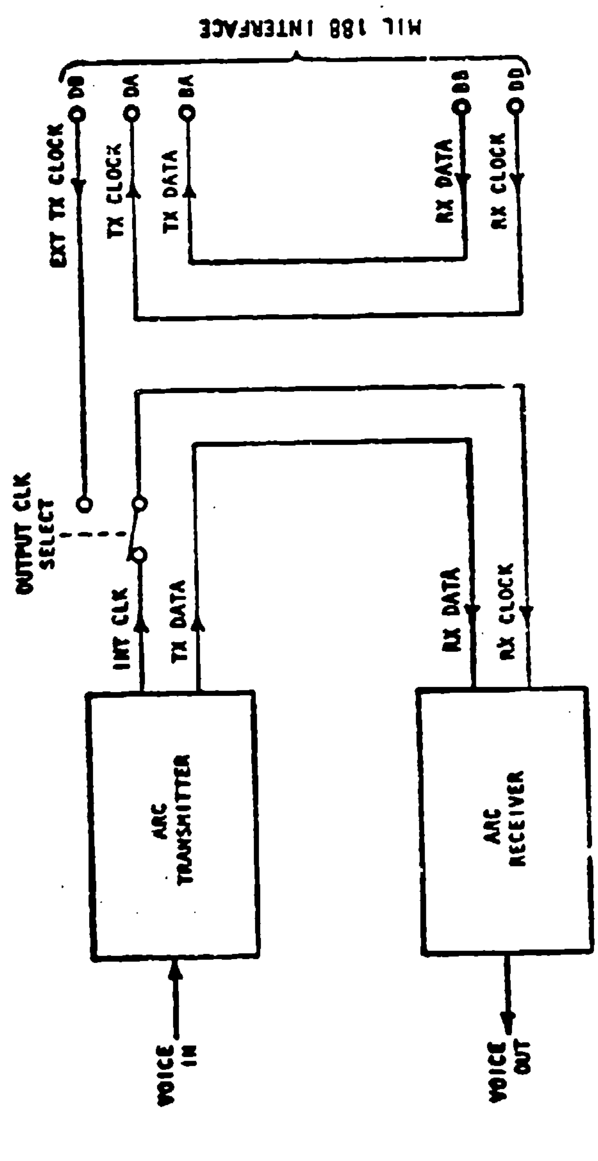

FIGURE A-2

LOOPBACK CONFIGURATION

TABLE A-2 CONTROL SWITCHES

CONTROL	LOCATION	FUNCTION
POWER ON/OFF switch	Panel	Controls the application of 115/230 volts ac power to the dc power supply and cooling fan motors.
MODE Control switches	Location A6 switches 1-3 on digital card	Switch 1. Controls bit rate: ON - 16K bps, OFF - 9.6K bps. Switches 2 and 3: MODE ARC — 2: ON, 3: ON MODE ADM — 2: OFF, 3: ON MODE CVSD — 2: OFF, 3: OFF
LOOPBACK switch	Location A6 switch 4 on digital card.	When ON it internally connects the transmitter output to the local receiver input. If the external clock (DB) is available on the MIL 188 connector (J7) it may be used for transmit and receive timing via the slide switch on the digital card. The effect of the loopback switch at the EIA interface is to loop SB to BA and DD to DA (see Figure 4-2).
Output CLOCK	Location C21 on digital card	When this slide switch is in the FORWARD position the internal clock (DA) is used for transmit output timing. The externally supplied clock (DB) is used when the switch is in the AFT position.
Tape Recorder IN and OUT switches	Panel	These switches connect either the tape recorder jacks (ON) or the handset (OFF) to the digitizer
FIFO Reset switch	Location A6 Switch 2 of smaller switch dip	Used to reset FIFO buffers after power is applied.

APPENDIX E

MODEM LAB TESTING

APPENDIX E

MODEM LAB TESTING

Prior to the test program, (3/29/78 and 3/30/78) a set of measurements were made on the two 16 kb/s modems to be used. These tests were made using an Axel 770 telephone line simulator, and tested the modem's capability of coping with noise, phase jitter and harmonic distortion. After the conclusion of the test program (5/2/78) the modem were again tested to ascertain if they had changed during the test program. Some data was again taken on 6/16/78. The results are presented in Figures E.1 through E.9. The two modems involved are designated as RADC#1 and RADC#2 as can be seen the overall performance between the beginning and end was close enough to assume that no modem performance change occurred during the testing program.

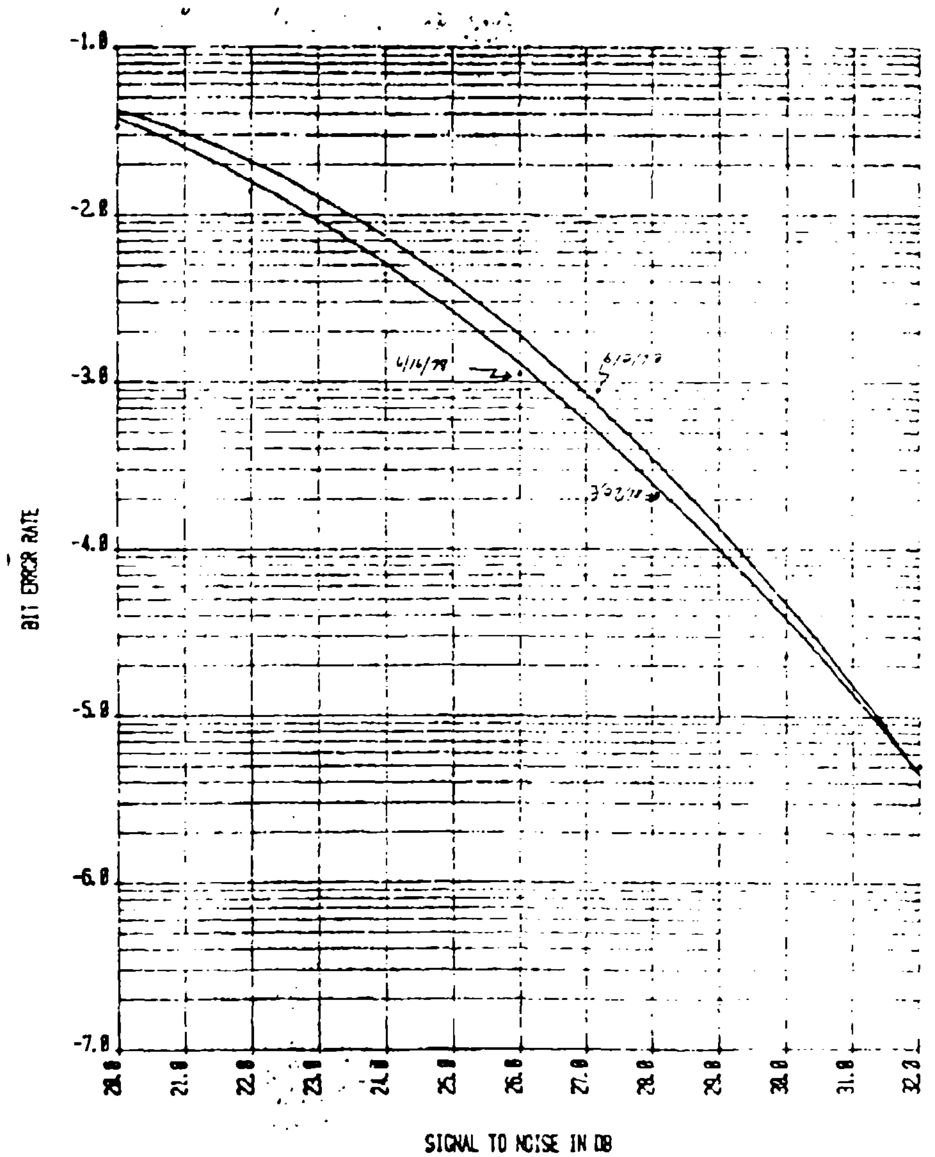

Figure E-1. RADC#1 3/29/78 and 5/2/78 C2 Line TX-6 RX-18

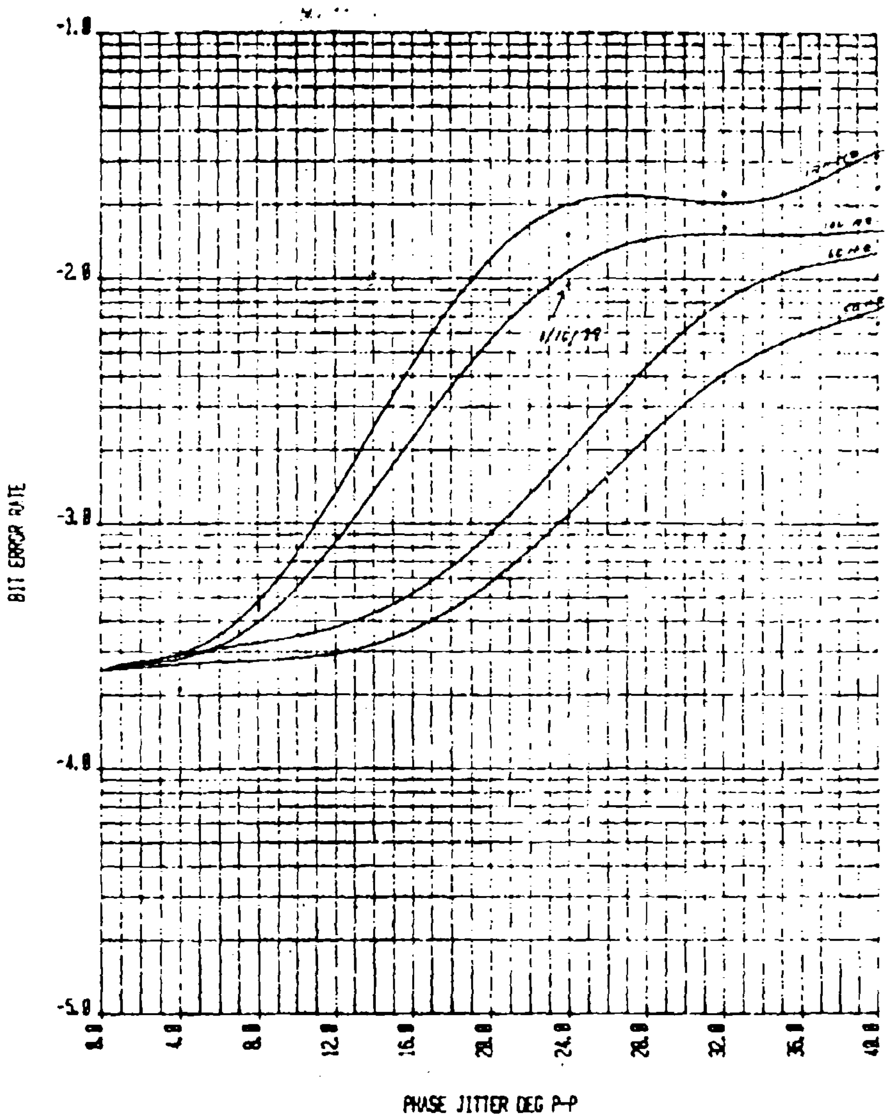

Figure E-2. RADC#1 3/29/78 C-2 Line TX-6 RX-18 S/N=28

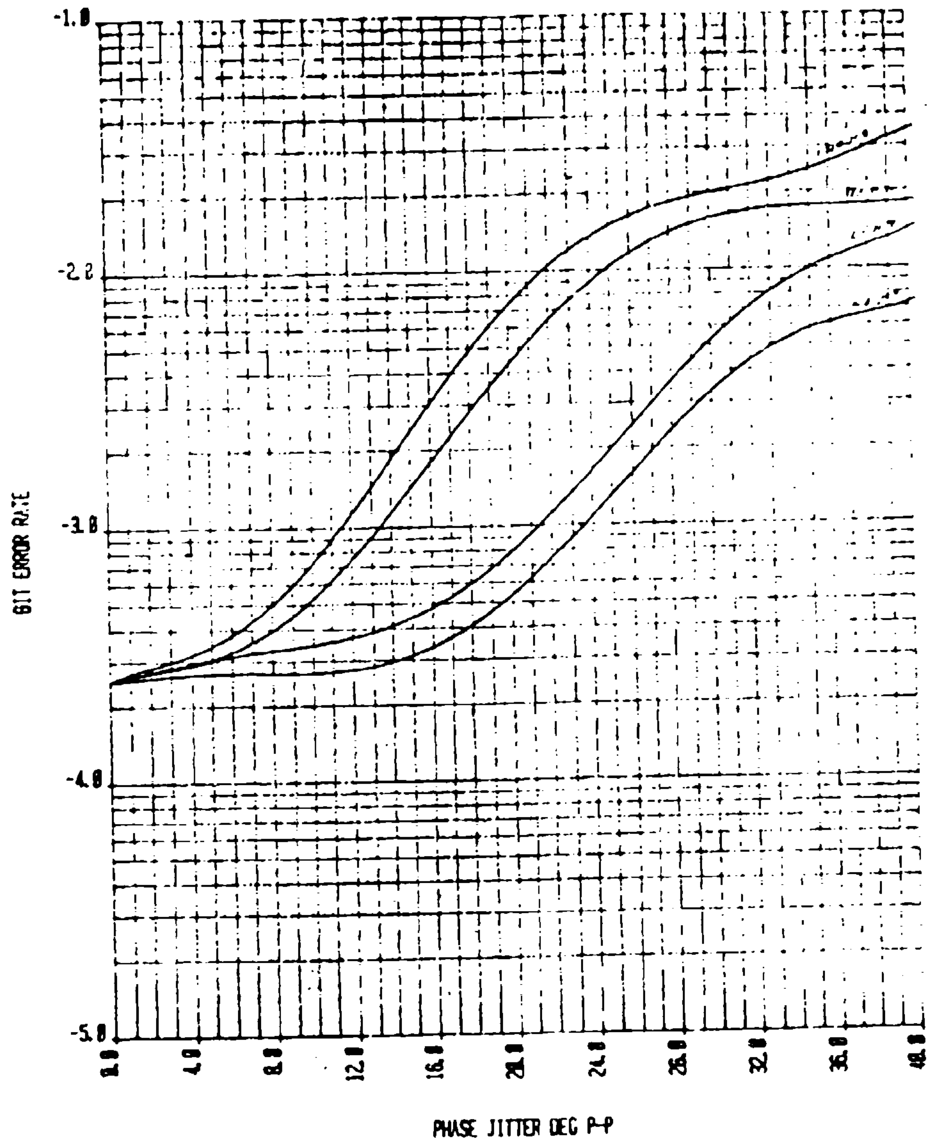

Figure E-3. RADC#1 5/2/78 C-2 Line TX-6 RX-18 S/N=28

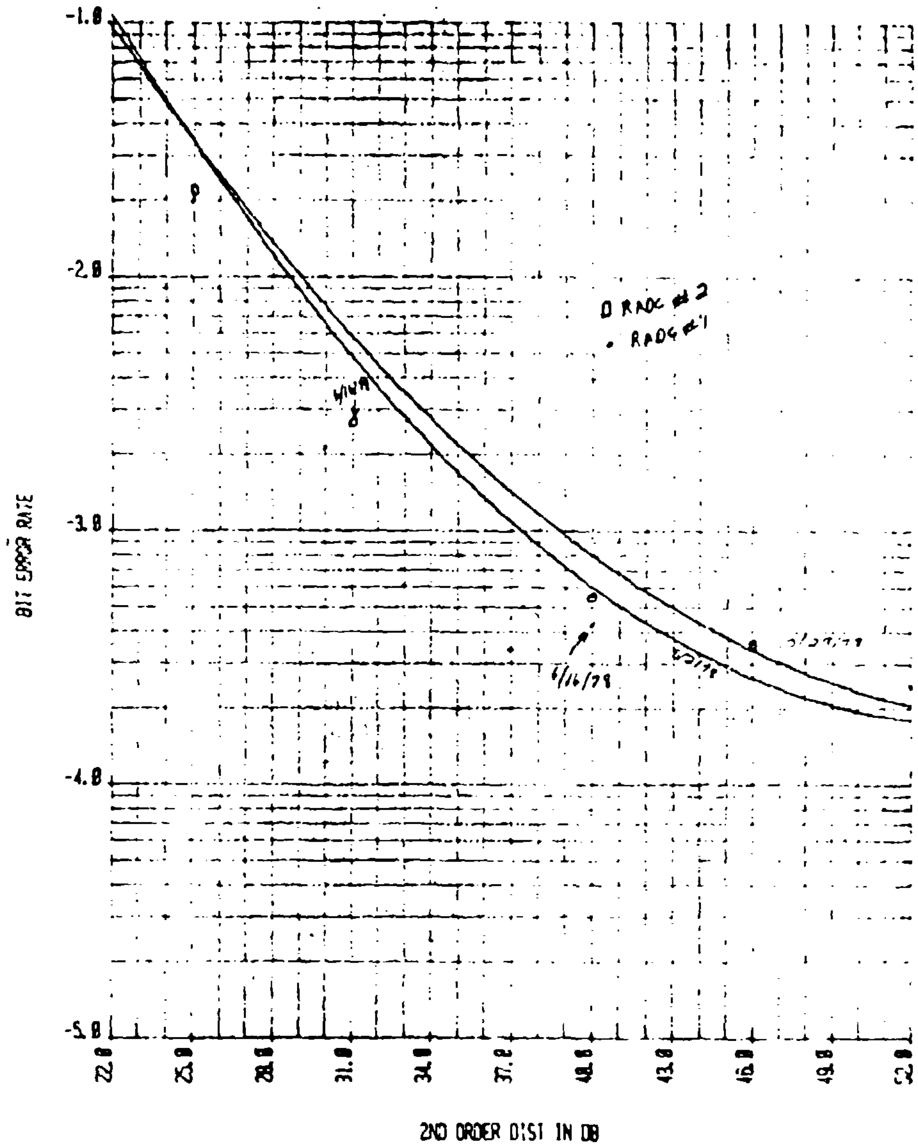

Figure E-4. RADC#1 3/29/78 and 5/2/78 C-2 Line TX-6 RX-18 S/N=28

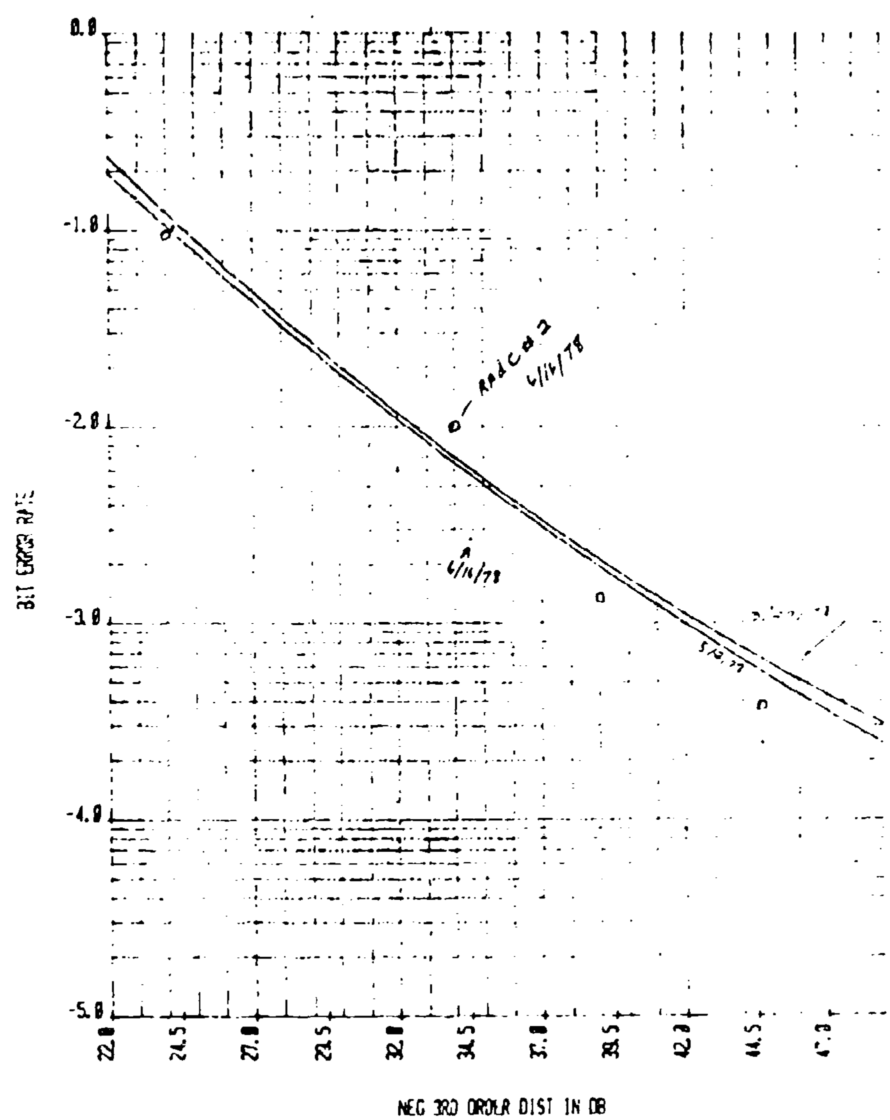

Figure E-5. RADC#1 3/29/78 and 5/2/78 C-2 Line TX-6 RX-18 S/N=28

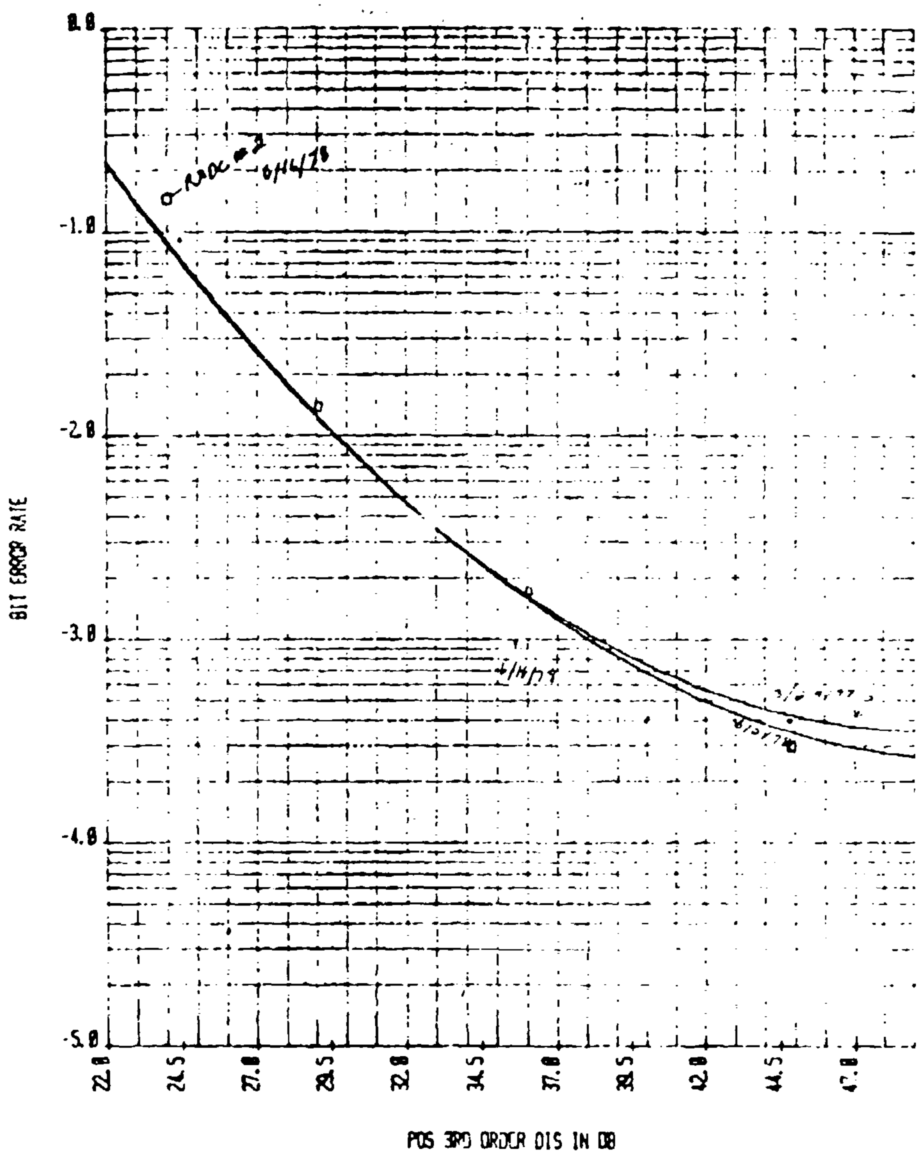

Figure E-6. RADC#1 3/29/78 and 5/2/78 C-2 Line TX-6 RX-18 S/N=?3

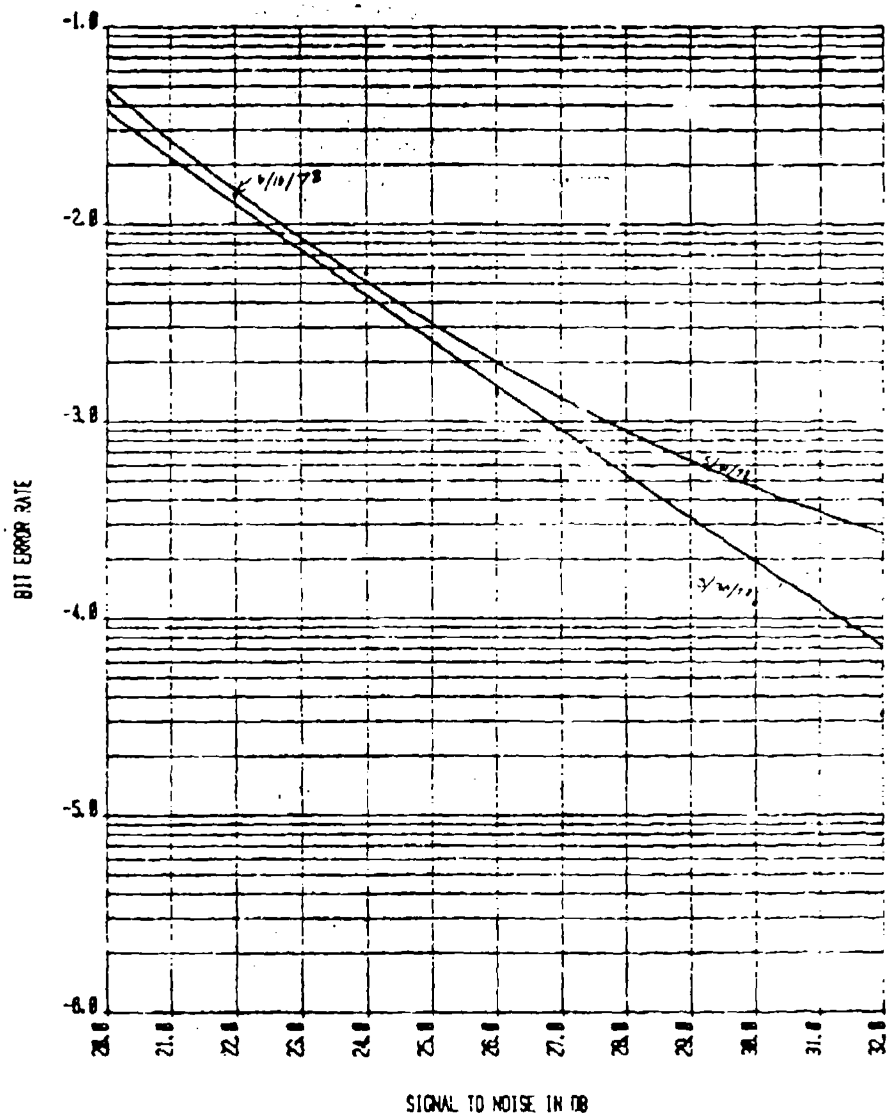

Figure E-7. RADC#2 3/30/78 and 5/2/78 C-2 Line TX-6 RX-16

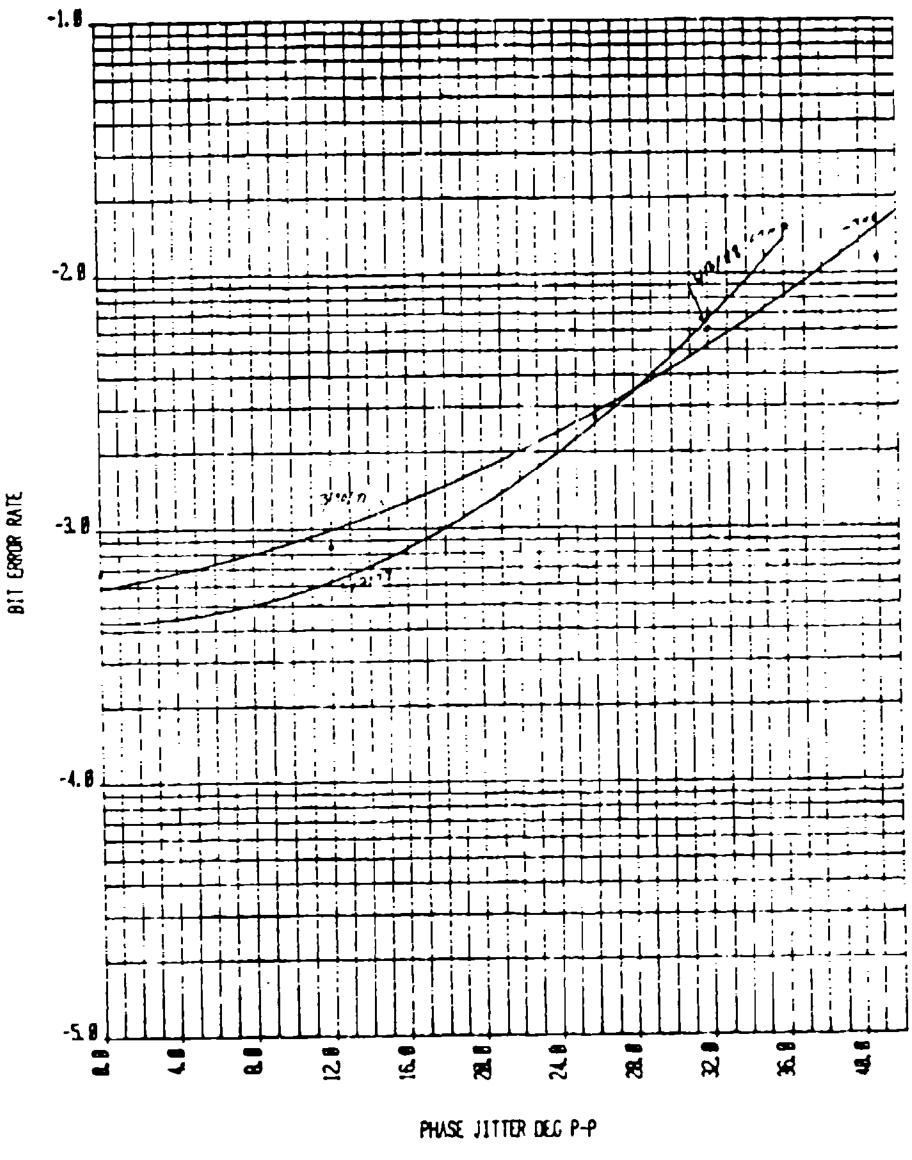

Figure E-8. RADC#2 3/30/78 and 5/2/78 C-2 Line TX-6 RX-16 28DBS/N

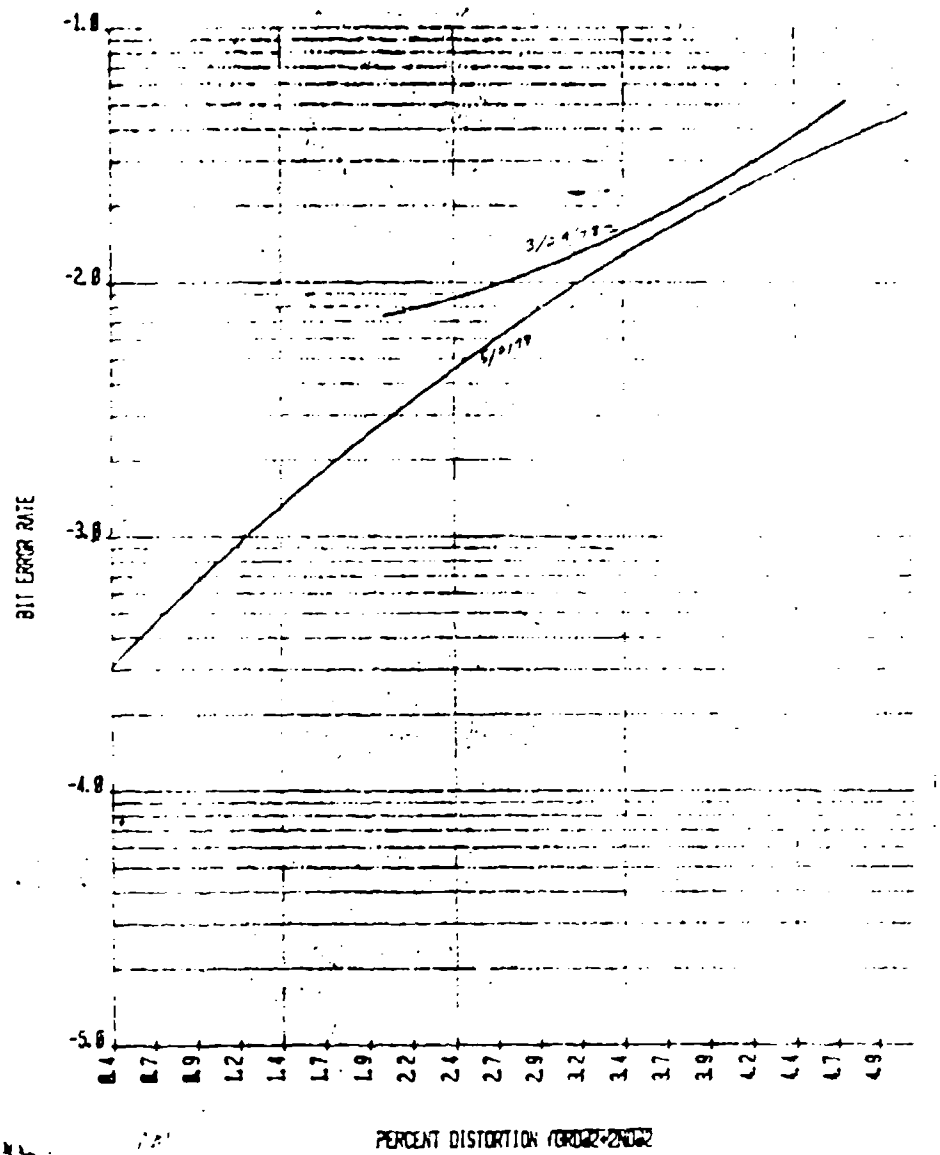

Figure E-9. RADC#2 3/29/78 and 5/2/78 C-2 Line TX-6 RX-16

DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY (AFMC)

1 Jun 04

MEMORANDUM FOR DTIC-OCQ
ATTN: Larry Downing
Ft. Belvoir, VA 22060-6218

FROM: AFRL/IFOIP

SUBJECT: Distribution Statement Change

1. The following documents have been reviewed and have been approved for Public Release; Distribution Unlimited:

ADB084552, "Project Birdwatch at Dover AFB", RADC-TR-84-7

ADB191869, "Acousto-Optic Beam Steering Study", RL-TR-94-121

AD0800669, "Use of Commercial Broadcast Facilities for Emergency DoD Communications", RADC-TR-66-392

ADB058979, "Multi-Rate Secure Processor Terminal Architecture Study", RADC-TR-81-77, Vol 1.

ADB053656, "16 KB/S Modem (AN/GCS-38) CONUS Test", RADC-TR-80-89

ADB055136, "VINSON/AUTOVON Interface Applique for the Modem, Digital Data, AN/GCS-8", RADC-TR-80-341

ADB043556, "16 KB/S Data Modem Partitioning", RADC-TR-79-278

ADB029131, "16 Kilobit Modem Evaluation", RADC-TR-78-127.

2. Please contact the undersigned should you have any questions regarding this document. Thank you very much for your time and attention to this matter.

Kelly Cagwin

KELLY CAGWIN
STINFO Officer
Information Directorate
315-330-7094/DSN 587-7094